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ROYAL

Geological Society of Cornwall.

FORTY-EIGHTH, FORTY-NINTH, & FIFTIETH

ANNUAL REPORTS

OF THE COUNCIL,

WITH

THE PRESIDENT'S ADDRESSES,

AND

PAPERS AND NOTICES

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Geological Society of Cornwall.

FORTY-EIGHTH

ANNUAL REPORT

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PRINTED BY W. CORNISH, BOOKSELLER AND STATIONER.

1861.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness.
Her Most Gracious Majesty the QUEEN.

Vice-Patron.
His Royal Highness the Prince Consort, K.G.,
Lord Warden of the Stannaries, &c.

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PRESIDENT'S ADDRESS.

In addressing you on this occasion, I shall refrain from making those remarks relative to geological topics, which usually come from the chair at these meetings, and for the elucidation of which this Society was organized. I am induced to do so, because I feel that we have important matters to come before us relating to the erection of the building which is necessary in order to place this Institution in that state of efficiency which we all desire to see it; and as we have not only a good deal of ordinary business to transact, but also to read those papers upon geological subjects which gentlemen have been kind enough to send us, I think that we must limit our scientific discussion to the consideration of those particular documents. Now, with regard to the new building, the subject is one which we have had before us year after year, for a very long period. I may say that ever since I became a member of the Society, and especially ever since I have had the honour of filling the office in which, through your favour, I have been placed, we have regularly had it brought before us. The attempts to obtain a satisfactory site for the building date back more than ten years ago. I have the letter-book of the Society before me, and I find there is an entry of a letter received on the subject of a site, dated the 17th October, 1850, and yet here we are in September, 1861—a year longer than the siege of Troy lasted—and still we are without a building. We have been seeking to establish the Society in a proper position, by providing for the security and proper classification and arrangements of the large and valuable collection which is contained in this room and other parts of this building, and of thus rendering our museum available for geological instruction and inquiry. Now, this collection alone, without reference to any further contributions

or to any further proceedings of the Society, is of such extent and importance, as fully to entitle it to a suitable building for its proper arrangement and protection. A large number of the specimens are of a rare, interesting, and valuable description, such as you cannot find in any other collection. I have not got an accurate report of the contents of the museum, but I may mention that there are no less than 6,000 fossils in our drawers belonging to the Devonian rocks, about 200 fossils belonging to the carboniferous rocks, and one drawer full of Silurian fossils, most interesting and valuable; but they are so huddled up together that they cannot be examined without injury; and such an eminent man as Professor Sedgwick recommends that we should not allow access to them as they are now placed, or until they are properly arranged. Until this is done, therefore, they cannot be examined by any one, however much he may desire to do so for scientific purposes, as they might be easily injured. We have also very valuable illustrations of the fossil Fauna and Flora of this county; and in the new building which we are seeking to erect, we should like to provide accomodation for their arrangement, feeling assured that they would not be without interest to the inhabitants of Cornwall. The minerological collection is very extensive and important; and it is highly desirable that it should be properly accommodated and protected, so as to render it available to the geologist, and to enable those connected with the School of Mines which has been recently established, to follow up their scientific investigations. The first and greatest difficulty which we have experienced in our endeavours to provide such a building, has been in the obtaining of a site. A site was suggested in a central part, or rather at the back, of the town, which was considered by many gentlemen to be a suitable position, but the obtaining of that ground has been involved in so many difficulties, there have been so many complicated arrangements relative to the transfer of the property, and so many obstacles have arisen, that we have been unable to surmount them. This is one and the principal reason why we have not been able to realize the object we desired. When, three years since, I undertook the duty of

presiding over this Society, I may say that I felt very strongly how incompetent as regards scientific knowledge I was to occupy such a position; but if there was one point on which I felt confidence, it was that I should further the great object which all who felt any interest in the prosperity of the Society desired to see accomplished; and the belief which led me to accept the office of your president was that I might assist in obtaining a suitable site and of securing the erection of a convenient and appropriate building on it for the Society. During the last three years, however, we have been in this position—we have been constantly under the hope that the site I have referred to might be obtained—but first one obstacle and then another has been thrown in the way, and that is one reason why such delay has occurred in the carrying out of these plans which are now on the table. As we advanced one step, then another obstacle has presented itself—no sooner was one difficulty overcome than another difficulty has arisen, and, as far as I can understand the matter, although we are told that there is now a prospect of a speedy settlement, it appears that the land, as far as the completion of its transfer is concerned, is in exactly the same state that it was in three years ago. Under these circumstances, it remains for the Society to determine whether they will remain any longer negotiating for this ground, or they will accept of another site, a highly eligible one, which they can obtain for the building. Last year the committee thought of several sites, amongst others of one piece of ground in this neighbourhood, but on communicating with the owner, Mr. Moore, it was found that he was unwilling to separate the portion that was required from the other part of the ground, and after some correspondence on the subject, there was an end of that. The committee went through the town, and several sites were suggested, but none of them were considered exactly suitable. The only site that was fixed upon was one situated at the bottom of the town, near to the railway station, on the estate of Mr. J. J. Rogers, of Penrose. The committee came to a resolution, which was worded very guardedly, to the effect that if no better or more appropriate site could be

secured, they recommended that the plot of ground opposite the railway station be procured as a site for the proposed building, and that the purchase be completed as soon as possible. I believe that many members of the committee entertained the same feeling as was indicated in the first part of the resolution—that it was only desirable to secure this site if no better one could be obtained. I for one have no hesitation, however, in stating that I consider the site in question a very desirable one; it is very open and light, there being no high buildings near to obstruct the light, which is an important matter, as it is very desirable that the situation should be such an one as will afford light sufficient for the examination of the various specimens when arranged—not merely light enough to view them when taken out of the cases and examined, but that the room should possess sufficient light to enable them to be clearly seen where they may be placed. This ground is open in every way, there being no buildings in the front or rear which would interfere with our building at any time. Then comes the question as to the situation. It may not be so convenient for those persons who reside in Penzance as would a site in the centre of the town, but it will be more so for those coming by railway from a distance to our meetings or to examine the museum. I am sure that persons coming from a distance will feel how desirable it will be to have the building as near the railway station as possible, for we know how often our proceedings are protracted till near the moment of starting, and how often gentlemen are hurried to catch the train. If this site should be selected, the railway would bring persons near to the doors of the building, and, when the meetings are over, they would only have to go a very short distance to step into the train on their return. I am only now speaking my own opinion, and I believe that I differ from some of the officers, many of the council, and a large portion of the members of the Society on this point. Next we come to the character of the building, and upon this point I may state that although it would be very desirable, as is thought by some members, that it should be of a rather imposing description —that it should have a handsome elevation—yet handsome

elevations unfortunately cost a great deal of money. Everybody would wish that the elevation should be composed of that fine stone which we have in this neighbourhood—fine cut granite, but that would cost a great deal of money; and rather than have no building at all, I think it would be more desirable to dispense with a granite elevation, and have one of a less costly character. Should our funds afterwards enable us to erect that description of elevation which everyone would wish such an Institution as this to possess, I for one shall be most happy, and I hope that at some future period we may look forward to being able to face the building with granite. In the arrangements of the building I trust we shall look to the real purpose for which it was intended —that we should not look too much to uniformity—that in the design for the museum we should keep utilitarian principles in view—that we shall arrange for upper lights so that every object may be seen to the best advantage; and that although we shall require a large room for our meetings, still that what we most require is a very large space in which to deposit our collection, possessing the advantage of top lights, so that all the specimens may be clearly seen. Unless you can command ample light, your museum will not be what we should desire, and any one who looks at the specimens in the cases in this room and finds how difficult it is to examine any of them, must feel thoroughly satisfied on this head. Then, again, the arrangement of some of the specimens must not be the same as that which we see in this room, because you cannot give by it that protection, and at the same time that facility for the examination of special and particular specimens, that you would desire. These specimens do not require large glass cases, like those round the room, but I confess that I look forward to have in the centre room of our place of meeting the means of greatly advancing the importance and success of the society itself, because I cannot help feeling that by the proper display of our collection, and particularly by making it the means of geological instruction, we shall achieve this desirable result. It is for that purpose that we require this increased accomodation. Geological science is fortunately no longer what it was some years

ago, when you and others were engaged in filling up and settling the great landmarks of the science. The frame-work of the science is almost completed, and what we are now doing is not so interesting as the former, though not less important, namely, the following out of the details and minor investigations arising from a further acquaintance with, and more extended knowledge of, the science; and this will, I believe, in a great measure, account for the fact of geological societies no longer possessing the popular interest which they formerly enjoyed. Still, in a county like Cornwall, where its material interest is so greatly concerned in the prosecution of geological research, it is the examination into these minor details that is so important. I shall not detain you any longer by any further observations on this point; but I must add before sitting down, that looking at the origin of this society, and the character of the building proposed to be erected, I consider the latter will be a most fitting and appropriate compliment to those eminent persons by whom the institution was founded; and if we desire to perpetuate their names, and to produce a lasting record of their connection with Cornwall, we cannot do better than erect this building, because I do not think that we can raise to their memory a more suitable memento than a building which will give the society an "outward and visible," convenient, and suitable position in the world. If any gentleman has any observations to offer on the subject of the proposed building, I beg that he will now do so, before we proceed with the reading of the papers, and the other business of the meeting. This plan shows what sort of building it will be, but it only conveys a general idea. Perhaps I ought also to state that the question is one in a great measure of means. I am afraid that unfortunately we have lost a good deal of the money promised us, through death and lapse of time, owing to our not calling on the parties who subscribed thirteen or fourteen years ago. Still, I am glad to say that I have received intimations from a great many parties that they should not allow this long interval of time to exonerate them from paying their subscriptions; and I may mention, among others, that Sir Charles Lemon has stated that he should take care

to make good his subscription of £300. I have also received a letter from Mrs. Tweedy stating that she intended to make good the subscription of her late husband, Mr. W. M. Tweedy. I have also received a letter from Mr. St. Aubyn, one of the members for the western division, who would have attended this meeting had it not been his having to attend his military duties at Bodmin, but he has promised a subscription. Mr. Charles Fox and other gentlemen have likewise promised subscriptions. Now as regards the funds which are or are likely to be at our disposal. The subscriptions which have been promised, and which we may now calculate upon receiving, amount to nearly £700,—namely, £683. Some of these subscriptions have been paid, but it appears they do not amount to above £130. I think, what with the further subscriptions we are pretty sure to receive, those promised, and the money we have in hand, I see my way pretty clearly to raising £1,500; and when it is found that we are really doing the work, that it is no longer a question of site, or a question of where the building is to be—when it is seen by the wealthy proprietors that we are in reality about to erect this important county building, I think we may safely calculate upon raising not less than £2,000. A building upon the plan proposed would cost something over that sum, but I think that probably reductions may be made by which some saving will be effected, and I think I see my way clearly to the raising of a sufficient sum to erect a building suitable for our purpose. I have gone into these details for the assurance of some parties who may feel some doubts as to our being able to raise the amount that will be required to complete the building.

THE FORTY-EIGHTH ANNUAL REPORT OF THE COUNCIL.

In presenting the annual report of the Council to the attention of the Society, it has been thought desirable on the present occasion to depart in some measure from the usual plan, and instead of reporting on the progress of the Society during the past year, only to extend it, and report on the subject generally and the position in which our society stands to Cornish geology, and the extent to which it is represented in our museum. By the efforts of various members of our society, as well as the labours of the Ordnance Survey, Cornwall has been demonstrated to contain portions of at least three of the great series of rocks. The northern and eastern part of the county is occupied by the carboniferous beds. These run diagonally across the county at its north-east corner, and continuous with the carboniferous of North Devon. The fossils representing these, in our museum, are not numerous, and those we have were chiefly presented by T. S. Pattison, Esq., formerly of Launceston, but now of London. A few specimens have been presented by others. This deposit will require further elucidation. The specimens are deposited in our drawers, but at present are unavailable for study, for they cannot be examined without liability to injury. The next and largest deposits are the old red sandstone. These form the great bulk of the county, and rest on the great granite centres. The fossils representing these are numerous and valuable, and extend from one end of the county to the other. These were chiefly contributed by Mr. C. W. Peach and Messrs. Couch; a large and valuable collection was purchased by our late treasurer—Joseph Carne, Esq.—and presented to our museum. These are

also deposited in our drawers and cabinets, and have undergone some sort of arrangement for further use. The plan adopted has had reference only to localities. All localities are arranged together. But from the number of specimens we have, and the limited space at our disposal, they are unavailable for study without risk of serious injury; and as these specimens are (many of them) illustrative of specimens in our *Transactions*, it is thought very undesirable to suffer them to be frequently examined till we have greater space. By the researches of some of our members—even from the commencement of our Society—it has been discovered that the whole of our shores from Cawsand Bay, in Plymouth Sound, to the Lizard, all around Mount's Bay, the Land's End, St. Ives Bay to Padstow, and to Hartland Point, were once surrounded by a most magnificent forest of trees; most magnificent, but of the same kind as those now living in England. These woods extended up all the valleys examined. Specimens of these woods are also sparingly deposited in our museum, together with the hazel nuts and branches of trees with their leaves; and from the *debris* sent us, the head and horns of the great Irish elk, red and fallow deer, common elk, hare, bones of the hedgehog, the *mammalia*, beetles, and other insects. All these are deposited in boxes, except the bones, which are open for inspection. But we have not space for their display, as illustrative of this deposit. The earthy deposits and gossans are almost unrepresented among us, and if offered for our acceptance we have at present no place for their accommodation. Mr. Rodd sent us specimens from the moors of the north, which are iron and assuming the enamillated form. Other specimens it would be desirable to procure when space can be afforded. Mr. W. J. Henwood's professional occupations have somewhat retarded the progress of our eighth volume; but about 174 pages have been printed, and four plates had been printed previously, and one lithographed during the past year. Nothing, however, is likely to interfere with its completion within the estimated period. The chart of the strike of the Cornish rocks, by Mr. Whitley, was a valuable one, and has greatly advanced Cornish geology. It would

be desirable now to ascertain the dip and cleavage over the same space. It would also be desirable to ascertain the various and relative ages of our granites, with their elevations and effects on the overlying slates. These are points which it will now be desirable to ascertain, and for which specimens illustrative of them should be forwarded to our museum. It is proposed that in future the proceedings of the annual meeting of the society be printed in a pamphlet form for immediate distribution.—The general report to be printed in the usual form afterward.

By order,

R. Q. Couch, *Secretary*.

Sept. 27th, 1861.

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3. Memoirs of the Geological Survey of India.
4. Annual Report of ditto.
5. Geology of Horsa, 2 vols.
6. Memoirs of Geological Survey of England.
7. Report of Geological Reconnaissance of the Northern Counties of Arkansas.
8. Proceedings of the Royal Society of Edinburgh.
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12. Proceedings of the Literary Society of Liverpool.
13. Proceedings of the Royal Institution of Cornwall. By the Society.
14. Madison, the capital of Wisconsin, its Growth and Progress, &c.
15. Reply to the "Statement of the Trustees" of the Dudley Observatory. By Benjamin A. Gould, jun.
16. Memoirs of the Natural Sciences of Cherbourg.
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ROYAL

Geological Society of Cornwall.

FORTY-NINTH

ANNUAL REPORT

OF THE COUNCIL,

WITH

THE PRESIDENT'S ADDRESS,

AND

PAPERS AND NOTICES

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PENZANCE:

PRINTED BY W. CORNISH, BOOKSELLER AND STATIONER.

1862.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness.

Her Most Gracious Majesty the QUEEN.

OFFICERS AND COUNCIL FOR THE YEAR 1862.

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ANNUAL MEETING, 1862.

In the absence of Mr. Augustus Smith, M.P. (the President), Mr. D. P. Le Grice, one of the Vice-presidents, took the chair; and, in addressing the meeting, said:—

I think it is requisite that I should explain the reason why I occupy the chair on the present occasion. As you are aware, it is the custom of this Society to elect four Vice-presidents every year, and as our talented and respected President, Mr. Smith, of the Scilly Islands, is unavoidably absent, and as I happen this year to be one of the Vice-presidents, and, unfortunately, the only one who is present, I am called upon, as an act of necessity, to take the chair, and to occupy a position which I am afraid I shall very inadequately fill. I believe that the first duty devolving on the person who takes the chair at our Annual Meetings is to notice the losses which we have sustained during the past year; and it is my painful duty to refer first, to the great loss which has befallen us in the death of the illustrious Prince Consort, who was a patron of this Society, and not only of this, but also of every similar scientific Society, as well as the friend of every scientific man in the kingdom. The loss of His Royal Highness, I need scarcely say, is severely felt by every man in the country, from the peer to the agricultural labourer, and it will be more particularly felt by one who in her descent will miss his supporting counsel and assistance, and by another who in his ascent will want his advice and guidance. The loss which we have next to deplore is that of one of ourselves—one who was present at our last Annual Meeting, and who took an active part in the proceedings, as he did in everything to which he put his hand. He was an original member of the Society, one of its Vice-presidents, and frequently a member of the Council. We are indebted to him for many

very valuable specimens, and also for his presence at every one of our Annual Meetings; at least I never attended a meeting of the Society at which he was absent. I need not say that I allude to the late Mr. Pearce. I believe I have been present at about forty meetings of the Society, and I never recollect being at one of them at which he was not there, and affording the benefit of his valuable aid and ready eloquence. I believe these are the only losses which the Society has sustained by death; and having referred to them I had better perhaps at once read the letter which has been received from Mr. Smith. It is as follows:—

"Tresco Abbey, 30th September, 1862.

"*To the Officers, Council, and Fellows of the Royal Geological Society of Cornwall.*

"Gentlemen,

"I have to make apologies for not being present at this year's Annual Meeting, to take the chair as President of the Royal Geological Society of Cornwall; but this was not in my power to accomplish without putting myself to very great personal inconvenience.

"I should not, however, have allowed this consideration to have weighed with me, could I have believed that my presence was essential on the present occasion, or likely to have proved of any real service to the Society as respects the attainment of that object which alone induced me to undertake a second term of office.

"From the first I was very sensibly aware that I was wanting for the most part in those scientific qualifications which your President ought to possess, but it was my aim and hope to have made up for such deficiencies in setting to work to accomplish that which has been talked of for so many years, viz., the erection of Buildings, such as the purposes of the Society require, and its valuable collections deserve: works the more necessary, as the first move towards the revival and permanent existence of an Institution in those proportions which it ought to present to the county and public at large.

"For three years I vainly struggled to bring this about, and I have felt very strongly throughout that the obstruction and delay occasioned by the special views and influences which prevailed in various quarters ought not to have operated as they have.

"I, therefore, ventured last year to submit to the Society a specific plan, both as to site and buildings, which I believed—and still believe—to be very preferable to any scheme that had been proposed or contemplated. That proposal, however, did not meet with that *ready* and *unanimous* support which I am sure, in the present condition of the Society, is essential to a successful and satisfactory issue, whatever plan may be adopted; and the views and influences, already alluded to, still prevailing, another year has passed away without anything like a firm foundation being reached for this important work.

"In the meantime I find through this unfortunate delay, much valuable assistance, both as to means and active exertion, has been lost, and cannot now be easily recovered: at least, if it is otherwise, I must leave the proof to those who have mainly contributed to bring about this state of things, and invite them to undertake the task of realizing the Society's desires, and which I feel I can no longer attempt to carry out with any confidence of success as their active agent.

"I also so fully confer in the expediency of the arrangement, which was understood when I was elected your President for two years, and which has been once already set aside in my favour, that it would, I am sure, be very undesirable to have it further suspended by any renewal of that office in myself.

"With grateful recollections of the high honour I have twice received at your hands, and regret only that I cannot give a better account of results during my Stewardship,—

"I have the honour to be,

"Gentlemen,

"Yours very faithfully and obliged,

"AUGUSTUS SMITH,

"President of the R.G.S.C."

I am sure that we all very much regret the receipt of this letter, because Mr. Smith has been most active and energetic in his endeavours to obtain that which we have all so long desired—a proper site for a new building for this Institution. This has been an object of the Society for the last twenty years, and I believe that in every address which has been delivered from this chair during that period, the want of a suitable room for our specimens has formed a prominent topic. Not only have we wanted room for the specimens in our possession, but we have lost many presentations of valuable specimens from not having space in which to display them. I am happy to be able now, however, to announce that we have accomplished the object which has been so long desired, and I am sorry that Mr. Smith is not now present, as I am sure he would be much gratified at learning that we have at last succeeded. We have obtained a site near Mr. Thomas Bolitho's entrance-gate, which is desirable in every respect; and I am happy to say that the transfer of the piece of ground in question—the glebe land—has been at length accomplished, and the land secured—at least it has passed from the church into the hands of Mr. Thomas Bolitho, and we have obtained a portion of it which is sufficient for our purpose—being 170 feet long by 35 feet wide.

THE FORTY-NINTH ANNUAL REPORT OF THE COUNCIL.

DURING the past year, the Council have been chiefly engaged in attempting to secure for the Society that enlarged accommodation which is essentially necessary to any future progress. For the last fifteen years a larger museum, with better arrangements for our collections, has been felt to be our great want, and has been so repeatedly pressed on the attention of the Society that it seemed to form an acknowledged portion of every Report.

The Council were again afraid that, while it was their duty to refer to the subject, they should be again unable to report any progress. During the last two months, however, the business has assumed a more definite form, and within the last fortnight the Glebe Land has been transferred to Mr. T. S. Bolitho. The sale having been effected, the front, or fair-field, will be devoted to the public buildings.

Two years ago, the Council accepted the site as convenient for the Society's purposes, and this acceptance was ratified by the Annual General Meeting.

After the last Annual Meeting, the Council and the Building Committee met several times on the ground, and made many enquiries as to the space that would be required. The Council asked for, and obtained, the whole of the western wing of any buildings that should be erected, as giving most light and offering most accommodation.

It was thought that we should require a frontage of 50 feet, inclusive of a 15 feet road; but from the whole of the available space being 170 feet it was found we could be accommodated with 47 feet only, inclusive of approaches; by this plan we shall obtain a frontage of 32 feet and 170 feet in depth, and this the Council

think will be sufficient for our requirements. The plans and arrangement of the rooms, windows, &c., must be determined on by subsequent arrangement, and to carry out which the Council recommend the re-appointment of the Building Committee, who shall manage the future development of the plans, and, when complete, shall submit them to the Council for their approval previously to their receiving the approval of the Society.

The whole of the ground on which the buildings will stand will be transferred by Mr. T. S. Bolitho to the Town Council of Penzance, and by them the western wing is to be transferred to the Geological Society by purchase for about £230.

The purchase by Mr. T. S. Bolitho being now complete, the committee of the Town Council ask "if the Geological Society will be now prepared to carry out their part of the scheme laid down in the Committee's report of the 24th January last. The Council recommend the Society to accept it, subject to the superintendence and direction of the Building Committee." No plan of the buildings has yet been adopted, and as it is desirable that the whole of the edifice should be uniform in design, the Council recommend that the Building Committee should have authority to arrange with the other Committees which will be appointed for that purpose by the Council to settle all the particulars of detail, subject to the subsequent approval of the Society.

With the increased accommodation which this building will supply, we shall have full space in which to lay out our collection, both of minerals and of fossils, so that they shall be always available for inspection or study.

The fossils are already very numerous, we are yearly adding to them, and when they are exposed they will represent very fully the fossil *Fauna* and *Flora* of the county. From their present inspection, it appears pretty evident that the whole of the county once formed the bed of a deep sea, deepest to the west and gradually getting shallower towards the north-east, where there are indications of a marshy *Flora*, and the boggy vegetables of a carboniferous period.

Mr. Henwood still continues his labours among the mineral deposits. The eighth volume, which is entirely given up to his researches, has advanced to the 222nd page, with lithographic plates and 16 woodcuts. This shows a progress during the past year of 48 pages and three large tables. At this rate of progress Mr. Henwood thinks it will now take three years before his labours will be finished: but from the labour he is bestowing on it, there can be no doubt it will form a very valuable contribution towards our knowledge of mineral deposits.

By order,

RICHARD Q. COUCH,
Secretary and Curator.

October 10th, 1862.

PRESIDENT'S ADDRESS.

In opening the proceedings at this our Annual Meeting, I will briefly refer to the progress of geological science since last I had the honour of addressing you. While the numerous publications connected with geological science testify to the continued and extending interest—the industrious activity and systematic exactness of its students in the collecting and recording new facts and data in almost every part of the habitable globe, two questions of wider and deeper moment, owing to their bearing on other great problems affecting mankind's own existence, have more especially claimed attention since I had the honour of addressing you from this chair, on those subjects for the cultivation and discussion of which this Society was founded. The Darwinian theory of development founding the pedigree of living nature upon the most elementary form of vitalized matter, and expanding into improved forms of excellence—under what is called the doctrine of natural selection—had just then been promulgated; and akin to this, as growing out of it—the question of the antiquity of man as an inhabitant of earth, has, in a still greater degree, stimulated the curiosity and exercised the intellectual ingenuity of the creature man in the event, history, and supposed changes incidental to his own terrestrial existence. As respects the theories of Mr. Darwin, however ably supported and elucidated by an extent of knowledge and observation, and set forth with all the charms of clear and nervous language, few writers can equal in these days, in the occasion to which I have referred, I made so bold (and I am now the more sensible of the temerity, since his views have been partially or entirely accepted by so large a portion of the scientific world)—I say I then made so bold as to express the difficulties I felt in assenting even occasionally to the facts adduced, much less to the propositions enunciated and derived from them. Subsequent

examination has not lessened those difficulties, but on the contrary has only confirmed the opinion then formed that no grounds, still less proofs, exist for this theory of development, and that as far as our knowledge reaches, or experience testifies, no change whatever has taken place, or is taking place, in any one species or individual of the animal creation, beyond very slight variations of a mere superficial and evanescent character which rarely become permanent, but for the most part return to their original type. Take, for instance, man himself. The Ethiopian represented on Egyptian paintings 4,000 years old, is exactly the Ethiopian of the present day. The skull of the Egyptian mummy of the same date does not differ from that of a modern Copt. But if there is any reality in the principle of development, not only should some specific, but even material generic, changes be observable by this time, or at least some tending towards it, after a lapse of about 200 generations. Yet the organic frame of man—the substantial clothing to that frame of muscles, veins, nerves, and flesh, with all their minute niceties of construction and functions are essentially the same that at any previous time man invariably presented. Amongst the proofs adduced of the antiquity of man's existence, the discovery of two skulls have of late been prominently brought forward, the one found by M. Schmerling some years since in the Engis Cave near Liège, and the other more recently (in 1859) in the cavern of Neanderthal, near Dusseldorff. The first of these two skulls, that of Engis, is certainly the more ancient, but presents no anomaly of any moment, and is readily referred by anatomists to the ordinary European race, as Professor Huxley describes it—"a fair average human skull which might have belonged to a philosopher, or might have contained the thoughtless brain of a savage." The skull from Neanderthal, on the other hand, presents such a peculiarity of form as indicative of a very low type of humanity, that could the geological proofs of its great antiquity be depended on, it might have assisted those whose prepossessions, like those of Sir Charles Lyell, are favourable to Darwinian hypothesis, and admitted its being adduced as a proof of the gradation of man into the ape, did not the more certainly

ancient one of Engis, in the same district, contradict such an inference. Sir Charles Lyell's conclusion in his 19th chapter, however, notwithstanding a certain inclination to an opposite direction—may be considered as decisive testimony as to the absence of any progressive development as far as man is concerned. The human skeleton of the Belgian caverns, of times coeval with the mammoth and other extinct mammalia, do not betray any signs of a marked departure in their structure, whether of skull or limb, from the modern standard of certain living races of the human family. In reference to the antiquity of man, the President remarked that there was one argument which had been much used, or rather assumed, which did not appear to him to be very satisfactory. He alluded to that which took for granted that the original condition of man when he came of age—in whatever form that came about—and took possession of his terrestrial estate, was one of barbarism, ignorance, and physical as well as mental degradation. Now, was the view correct that man at his first creation exhibited a state of barbarism and ignorance, and grew gradually into a civilized being, both as to his mental attainment and physical condition, by slow culture and a process of inventive industrial experience and training? Looking to the analogy of the lower animals, who must all have been first created and endowed with their several instincts, it seemed more reasonable to believe that man, with his higher natural conformation must also on his first appearance on the surface of the earth have been endowed with no ordinary amount of inherent and intuitive knowledge, and that in a very short period, as the race multiplied and increased, their concentrated energies, under their primeval parent, must have very soon mastered and matured the rudiments, and exhibited the fruits, to a certain point at least, of all those arts and sciences, as well as the habits and conditions of life, which now constituted that state which was called civilization, as opposed to the barbarism of savages; and that, again, this condition of barbarism was produced, on the other hand, by a too quick and distant dispersion of certain branches of the human race amidst wild regions in which all communication with the parent stock was soon cut off,

and the severe exigencies of life interfered with the preservation and culture of the superior tribes and knowledge really inherited, till all traces of such were obliterated and their recovery rendered impossible. We know in the present day how soon a few isolated beings cut off from all communication with the rest of the world, and forced to apply all their energies and time to obtain a bare subsistence, degenerated into a state of savage barbarism, and how many individuals thrown among barbarous tribes, soon became as one with the people among whom their lot was cast. After some illustrations of the rise and fall of civilization in different times and places, he inferred therefrom that no great lapse of time was necessary, as had been contended, for the progressive advance of nations. Looking to the terrestrial conditions of the glacial geological epoch, there were peculiar difficulties which seemed to meet those who contend that all geological phenomena might be attributed to causes identical in nature and degree with those now in operation. And why should earth be free from occasional and sudden revolutions, to which, it appeared, the sun itself, the centre of our system, as well as other greater suns, the centres of other systems, were occasionally subject? Surely if such vast bodies in the heavens, to which our earth was in comparison such a tiny speck, were at periods subject to violent changes, there could be nothing irrational in the belief that the crust of this planet, which Sir William Armstrong told us was no thicker than the skin of a peach compared with its body, might be from time to time warped or swelled, or displaced through some internal or external causes, over vast areas of its surface, which though scarcely affecting the body itself would suffice to drown whole continents of a sudden, or drain equal areas of the ocean by upheavement.

The President next proceeded to notice the subject of the exhaustion of our coal-fields, as referred to by Sir William Armstrong, in his Address at the opening of the Meeting of the British Association, at Newcastle, last month. He then said—

In entering on that painful portion of the president's duty which records publicly the loss of those Fellows of the Society whom

death has removed from among us, the account this year is, in one sense, heavier than usual, from the eminence as well as the intimate and immediate connection of the individuals with the proceedings of our Institution. Mr. John Taylor was a gentleman, though a native of Norwich, well known in this county as closely connected from an early period of a very long life—reaching to 83 years—with the mining undertakings of both Devon and Cornwall. His ability, energy, and, above all, his high character, raised him at once to a prominent position among those who adventured in the metallic mining interest of the kingdom, and he had the merit of being one of the first to introduce into the mining districts the capital of other parts of the kingdom. In 1819, the Consolidated Mines at Gwennap, under his care, attained an eminence of success which made their name, as well as that of Mr. Taylor, universally known and held in all honour. In Derbyshire, Wales, and the northern counties, Mr. Taylor's enlarged views and mechanical skill proved subsequently equally successful, and associated with his sons, John and Richard, the firm of Taylor and Sons has of late years been known, and known only to be appreciated in every mining district of the United Kingdom, in Germany, France, Spain, and Italy,—in America and Australia. Mr. Taylor further occupied a prominent position in the scientific world, and among other numerous important papers from his hand, his Report on Mineral Veins was much noticed at the meeting at Cambridge, in 1833, of the British Association, of which Institution he was one of the original founders and trustees, as well as treasurer from its commencement. But I have now to record a loss which comes nearer home to our body. At our last meeting there was brought to your notice the death of Mr. Richard Pearce, not only one of the original members of this Society, but one who was as constant an attendant at its meetings as he was of every other public institution connected with his native town—duties which he undertook in a thorough spirit of disinterestedness and earnest desire to be of public service. On this occasion we have further to deplore the loss of his son-in-law, Mr. Richard Quiller Couch, for many years secretary of our Society, and one of its chief and constant

contributors to its published *Transactions*. Mr. Couch was born at Polperro, in Cornwall, March, 1817, so that he had but just completed his 46th year. The son of Mr. Jonathan Couch, who was then and still is practising as a surgeon in that retired locality, with the paternal ability for, and distinction in, the same profession, he inherited and followed out, during his leisure hours, his father's eminent devotion to all branches of natural history, more especially to that of ichthyology. In this Mr. Couch, the elder, stood first and foremost in the kingdom; and but for his labours and those of his talented son, Yarrell's celebrated volumes on "British Fishes" would have been deprived of much of the newest and most valuable information which they imparted. After completing his professional studies at the London hospitals, Mr. Couch settled as a surgeon at Penzance in 1845, where he continued to reside, and enjoyed an extensive practice, till the day of his death. Immediately on his establishment in this town he became a member of the Royal Geological Society of Cornwall, and was at the same time appointed curator of the museum, In 1850 he became joint-secretary with Mr. Pidwell; and from 1852 till the present time he was both secretary and curator. His chief papers, to be found in our *Transactions*, relate to the fossil geology of Cornwall, and to those volumes I must refer those who desire to appreciate as they deserve, his geological knowledge and researches—the papers being too numerous for me to record here by their titles. In the *Transactions* of the Penzance Natural History and Antiquarian Society, appear from his pen many excellent notices on the botany and zoology of Cornwall; those on the migration of the pilchard, on the mackerel, and on the luminosity of the sea, being especially deserving of attention. His paper, published by the Polytechnic Society, on "The diseases and mortality prevailing among miners," startled not a little the public attention, and has created a painful and lasting sensation, which impresses all who take an interest in that valuable and labouring class of the sons of British industry, with a conviction that his conclusions were not hastily formed, and that every effort should be taken for the adoption of measures of such sanitary

precautions as may somewhat lengthen their span of life to that more ordinarily enjoyed by other sections of the working classes. So high was the reputation of this work, that it was translated into French, and is to be found in the Reports of the Institution of France. The vacancy in the secretaryship of this Society, occasioned by Mr. Couch's premature decease, is of that character which for the present will not be easily supplied, and is not the least of the embarrassments which, particularly at this moment, beset its crippled condition.

The President then continued—

It is now my duty to draw your attention to the position and prospects of the Society itself, and more especially to that never-ending and ever-complicated question—as it has unfortunately turned out—respecting the new buildings. This to me is a most ungrateful task, when I have to survey the delays that have arisen, the cause of those delays, the several transactions that have hampered our proceedings, the promises of blossom held out, the manner in which those promises have fruited, and the unexpected hindrances—chiefly arising from a complication of local, personal, and often petty, interests—which have marred what was about as simple a matter of business as could be well imagined, had it been treated as it ought to have been from the first, in a clear, straightforward spirit, and been allowed that independent action and character which such a public and county institution ought to have enjoyed. When I first had the honour of being called to the chair, in 1858, my chief apology for presuming to accept the office was in the hope that I might be able to carry out a design which had for years been in contemplation, and in aid of which liberal contributions had already not only been promised, but, in many instances, paid. A suitable site was the chief difficulty, and this seemed fairly to have been secured, when Mr. Thomas S. Bolitho—a gentleman whose public spirit is supposed to have very much at heart the welfare of his native town, and in which he undoubtedly exercises very great influence —announced that he was in treaty for the purchase of a certain property, called the Glebe Field, and on a portion of which, we

were given to understand, such a site would for certain be placed at our option. Some three or, at the furthest, six months, was declared to be the term when everything might be expected to be arranged in reference to this purchase. A year, however, elapsed, and the completion seemed as far off as ever; and as the business was in the hands of the lawyers, and there were many parties, clerical and lay, municipal, episcopal, and parochial, besides the ecclesiastical commissioners, mixed up in the proceedings, any one of common experience ought at once to have felt satisfied that the next geological epoch of the globe was as likely to be near at hand, as an early certainty of a site on the Glebe Field for the Geological Museum. The prospect was, however, constantly dangled as within our grasp, and we were told only to open our mouths and shut our eyes, and the desired morsel would soon be dropped in. It now began to appear, however, that a site, purely and simply as our own, was not exactly what was intended, and that Mr. Bolitho had a project, and for which design plans had been prepared by Mr. J. Matthews, the intelligent town-surveyor, by which a building was to be erected for the joint accommodation of the Municipality of Penzance, the County-court judge, a public library, halls for concerts and assemblies, and the Geological Society, with certain portions, as to entrances and staircases, to be common to all. Our Society, however, was not prepared to join in this close companionship, but consented to form a portion or wing of the edifice itself, but requiring to be thoroughly independent in all other respects. The difficulties arising even from this arrangement I always felt would be such as were likely not to be very easily surmounted, as the style of building and of accommodation required for one party might not exactly be suited to meet the exigencies of the others; and as architectural ambition called for elevations of a certain pretension, and that the same should be of choice granite as to material, I was always apprehensive the internal arrangements were in danger of being sacrificed to our external clothing, and considerable expense likely to be incurred on points comparatively unessential. I was, however, sanguine enough to hope that as the principles necessary to be kept in view

as to the internal arrangements of the municipal courts, especially, as to light and ventilation, were so identical with our own, that no real danger existed that the buildings would not be what they ought to be, in these all-important particulars. Without entering on various intermediate proceedings (amongst others a proposal from myself, for the erection of the geological buildings on an eligible site close to the railway station, and which, though approved generally by the supporters and subscribers resident in the county was negatived by the smaller though more numerous contributors of the Penzance district), I come to the month of January, 1862—in the fourth year of my presidency—when I received two communications,—one from the town-clerk of Penzance, informing me that Mr. T. S. Bolitho having now the transfer of the Glebe land, was in a position to treat with the Geological Society for a site for their buildings; while another from Mr. Bolitho himself stated that he had engaged with the town council, on their executing the deed, to offer them the plot marked out by them, 170 feet by 170 feet, and they would be prepared to sell to the Geological Society and any other institution. These two statements were somewhat at variance, and while the town clerk stated Mr. Bolitho was prepared to sell, Mr. Bolitho announced the same on behalf of the town council; but which was the principal in the business was not very clear, though it seemed clear enough that we had two instead of one party to deal with. But as far as our Society was concerned it was evident the original understanding of a site, as I had imagined, direct and independent for the Geological Society, was now ignored, and we were seemingly delivered over to be dealt with as they pleased into the hands of the town council, who, however, in their turn, as was subsequently developed, seemed at the same time to be held under other control. The transfer in the meantime was not quite so near its birth as had been announced, and the usual miscalculation as to time occurred before the actual delivery of the deed. Some months, however, after the above announcement, in the course of October, Mr. Bolitho was able to rejoice that the glebe land was his own property. Some time previous to this

event, a communication from Mr. Bolitho to the town council, dated the 6th of September, 1861, came to light, but of which no copy had been furnished at the time to the Geological Society. This document is so important that I must be allowed to introduce it at length.

"Penalverne, 6th September, 1861.

"Dear Sir,

"It is more than probable that the purchase of the Glebe Field will be completed by me in November at £1,800, and although, of course, till the deeds are signed it would be premature to make any definite arrangement regarding the public buildings that have been so long talked of, I think it better, in order that there may be no misunderstanding hereafter, to reduce to writing what I intend to do. In case the fields become my property at any time within five years from this date, I undertake immediately on the purchase being completed to sell to you, or such other person or persons as you may nominate, a plot at the south-eastern end, including Hill's house and premises, say 170 feet frontage from the western end of Northcott's house, and 170 feet in depth, the price to be 7–18ths of the sum I may pay, including the amount of surveyors' and commissioners' fees and deeds of conveyance, as well as the deed from myself to you or your nominee. And in consideration of my having a right of road at the eastern end of the proposed building to my fields, I shall be willing to give up £25. It is to be understood—

"1st.—That no building shall be erected by me or my successors on the western side of the plot, within 170 feet in depth from the street without your sanction.

"2nd.—That no building shall be erected on the plot unless the design shall have been first approved of on my behalf, and on behalf of the mayor for the time being, by Mr. John Matthews, or such other person as may be selected by him and myself, in the event of Mr. Matthews being unable or disqualified to attend to it.

"I am, Dear Sir,

"Yours faithfully,

"T. S. BOLITHO."

"S. Higgs, Esq. (the then mayor)."

Two passages in this letter are very remarkable:—That in which Mr. T. S. Bolitho engages to sell to the town council, or such other person as might be nominated by them, placing us therefore entirely at their mercy, which, after his previous understanding with the Geological Society, was not quite fair to our body. The other paragraph contained a still more remarkable condition, requiring that all buildings erected should be first approved on Mr. T. S. Bolitho's behalf by Mr. John Matthews. Thus after having been in the first place handed over to the will and pleasure of the town council, we in the next place were subjected to the taste, talents, and tutelage of Mr. John Matthews, a very worthy individual no doubt, and efficient town surveyor, but who has no real knowledge or experience, as I shall take the liberty of stating, as a builder, much less as an architect. The real long and short of the whole matter is, that while Mr. Bolitho was making over certain accommodation for public purposes, the whole direction and control as to the mode, manner, and fashion of their being carried out, and the employment of Mr. Matthews, was evidently an absolute condition from the very first.—Had Mr. Bolitho proposed to have handed over these sites to others on very liberal terms, and some sacrifice to himself, on the maxim of not looking a gift horse in the mouth, these restrictions might have been not so objectionable, but considering the rate of payment was quite equal to, if not in excess of, the rate which would be paid for the whole property, the proposition, to say the least of it, was somewhat singular, though not more so than it should have been accepted in the main by the parties concerned. The town council, whose local pride would, of course, not allow their questioning Mr. Matthews's or Mr. Bolitho's architectural taste and skill, naturally felt no hesitation as to the conditions; but the Geological Building Committee, having the fear of the architectural world before them, though very desirous of objecting as little as possible to Mr. T. S. Bolitho's restrictions, and being really also desirous to help out Mr. Matthews's attempts as an architect, agreed only conditionally to the terms, and required that all plans should be submitted to some regularly-educated architect of eminence to be

sanctioned by the society, while they had further to be submitted to and approved of by the Council as well as the Geological Society of Cornwall itself. Under these precautions, I was in hopes that the building plans might have been matured and brought into a satisfactory shape, and I can only say, for my own part, I was most anxious to have secured such a result if possible. A meeting between the town council and the Geological committee was, to be sure, not very encouraging; and such a meeting was much too large for a really close and accurate examination of the plans proposed. I believe certain comments of mine on the arrangement proposed in the public office wing were not very acceptable, and deemed somewhat impertinent. The town council and county court judge had, or were supposed to have, examined and sanctioned, and that was enough; but as the same were to be assisted by a grant of public money, I hold any one is entitled to give their opinion on their construction. But further, as the court as designed was planned against all rules for such edifices, on the points of light and ventilation, I felt a personal interest in the building, in which I might chance to be called to sit as a magistrate or juryman, or to appear as a plaintiff or defendant in some suit. But my chief object in noticing these glaring defects arose from feeling assured that the defects of the geological portion of the building were caused very much by their being obliged to correspond and depend therefore on the construction of the other wing. Had these wings been designed so as to run forward some thirty or forty feet in advance of the central block, forming a half H, everything would have been easily attained as to light and air; but, for some inscrutable objections, this has from first to last been most unaccountably ignored and opposed, and neither of the parties have been able to perceive that a hall with windows only on one side, and into which, from the aspect of the building, the sun can never shine, and in front of which high buildings may be reared within thirty feet, must necessarily be dark, even though the whole side was of glass. The plans have been considerably altered from time to time, but I cannot say improved, or any attempt made to amend the main and fundamental objections

which have been pointed out from the first. Though the Geological Society, and more especially myself, had been continually accused of being the main cause of the delay in the building scheme not being set going, it was in vain that I asked to be allowed to see the amended plans, when at length, in the month of March, an elevation only of the chief front was forwarded by our late secretary, Mr. Couch, with a further promise that the plans should follow. These, however, did not make their appearance till months after, and the elevation sent I subsequently found was different to that which was submitted to Mr. Smirke, who had kindly undertaken the invidious task of their revision. It was not till Saturday last that such an important element in judging of a building was produced. Mr. Smirke's remarks are well worth the attention of all the three parties concerned in these buildings, and fully bear out the objections that have been urged both to their general arrangement and architectural design, and ought to make them thoroughly re-consider the scheme as a whole, and hesitate before an irrevocable resolution to erect a range of public buildings, which neither internally or externally will be any credit to such a town as Penzance. Mr. Smirke, in his report as respects the geological portion, points out several defects in the arrangements and design; these as respects the latter are in common with the architectural elevation of the whole building. They first refer to the main entrance on the west side, the access to which is by a narrow road, only seven feet wide. The impropriety of bringing down the windows so near the floor is further pointed out, as well as their narrowness, and want of proper proportion. Mr. Smirke says, "the sills of the windows should be raised higher from the floor, so as to allow wall cases under them, and the light should be more generally distributed through the room." This question of light is more important than any other, and its effective distribution by the placing the windows high up, with their heads as near as possible to the ceiling, was also always insisted on; yet the windows in Mr. Matthews's plans are brought down close to the floor; while their heads do not reach within 4½ feet of the ceiling, which must consequently always be dark, and not act as

it ought as a reflector. The position of the Society in consequence is one of serious embarrassment, as though no plan can be carried out without our approval, we, at the same time, are not free agents to carry out what we really wish or what may be most suitable to our objects and means; and, while those occupying the opposite portion of the edifice are altogether free from any interference on the part of the Geological Society, the Society can do nothing without the approval of the town council in the first place, and of Mr. T. S. Bolitho, or rather of Mr. Matthews, acting on his behalf, in the second place. These observations and strictures, I trust, will not be misconstrued. I have had a hard and invidious task—I should rather say duty—to perform. I am quite ready to admit that in what I have objected to, and contended for, I have found myself almost single, and that the support and concurrence I have received from the building committee and members of the council has been rather passive than active, and not from any absolute conviction of the correctness of the views and opinions contended for. I have more than once been met with the observation —"Yes, that may be your opinion, and it may be all very right, but others hold a different opinion." Such observations, of course, at once ignore that there are certain principles and rules in the arrangement, construction, and design of buildings, which cannot be violated with impunity; and it is useless arguing with persons who are not aware that such exist, but claim all such to be mere matter of opinion. It might as well be affirmed that language was independent of grammar, as we know many persons practically prove. There are, however, certain obvious arrangements which involve the principles and laws of light, ventilation, and acoustics (and such laws I must respectfully submit are not matters of opinion but of proof and fact), which in all rooms or halls for public purposes are all-important, and the neglect of which is altogether unpardonable. For myself I can safely say I have no personal interest in the matter. My sole object has been to promote and secure such a plan as may be most fitted for the Geological Society in the first place, and in the second place that any united scheme may be such as may be really effective for the public

purposes in view, and as a structure be creditable in point of architecture to such a town as Penzance, for the welfare and character of which as a friend and neighbour, and constant passenger through it, and a sort of feeling that I almost belong to it, I claim also to be not altogether indifferent, and that in a thoroughly disinterested spirit. Now that this flourishing and popular town has been brought in close contact with the rest of the world—as close as such a railway as that of West Cornwall will allow—it must be content in its public undertakings to be subject to such criticisms as the architectural knowledge of the world will not fail to make, and the mode of carrying such into effect will not less be a matter of observation and comment. This has been anything but satisfactory. In such a joint scheme for public buildings, a thorough understanding and unity of action was indispensible, and this, instead of being secured by an arrangement between the parties themselves, has been sought to be provided for by the mode and quarter in which a reservation of all real power has been secured. In the outset of such a joint scheme for public buildings, after each body had settled the amount of their own requirements, had the arrangements, as far as their joint concert was necessary, been confided to a committee of three, one chosen by each of the parties concerned, a general outline of a satisfactory character would, I believe, have been the result. To them should have been delegated powers to advertise for plans, in the first instance, either leaving this to public competition, or by invitation to a certain number of architects of note; and, subsequently, the execution of the same should be carried out by public tenders. This point still, at least, remains open. The whole of this scheme, however, has been so ordered by its proposers—so cribbed and cabined by conditions—as to make the choice of the architect and the plan itself, consequently, a predestinated conclusion. In no place ought all schemes of public improvement to be more jealously watched and carefully considered than in Penzance, of which the natural advantages as to site have been so irregularly and unfortunately marred by a collision of interests, acting in opposition instead of combination,

by which the public, and I believe the private, interests of individuals, have suffered to a still greater degree. The building of the new church ought to operate as a wholesale warning on this point. A vast sum of money was expended on that edifice, and a vast amount of excellent and substantial work is displayed in its construction; but, through want of attention to the claims of architectural science and knowledge, it stands as a specimen eminently successful of a style which goes by the name of carpenter's Gothic. If care is not taken in these proposed new public buildings, Penzance will have to boast of a corresponding specimen of carpenter's Italian not less conspicuous. That such an opportunity should be lost for the erection of an edifice creditable as to architectural taste, plan, and construction, is much to be lamented. I have now discharged a most ungrateful task, which I felt, however, imposed on me; and I should not have said what I have, but for various attacks which I have had to encounter, and a desire not only to vindicate my conduct as your president, but to prove that I had good and substantial grounds for the objections urged. In this Mr. Smirke's remarks have more than justified whatever has fallen from me. I trust that as the buildings rise under the care of those to whom the chief direction of your affairs may be committed, and the exertions of those to whom we are indebted for our present position, that their aspect will disarm criticism, at least, if they do not elicit applause, and that they will at least be sufficient, though they may not be perfect, for the scientific, artistic, and municipal and judicial accommodation they are intended to supply. A report in detail respecting the building plans will presently be presented for your consideration, when the recommendation of the Council will afford every opportunity for a full discussion of the subject.

THE FIFTIETH ANNUAL REPORT OF THE COUNCIL.

THE Council, in presenting their fiftieth annual report, have the painful duty of recording the irreparable loss the Society has sustained by the death of Richard Quiller Couch, Esq., who so ably discharged the duties of curator from the year 1845, together with those of secretary from 1850. The many admirable reports and memoirs with which his prolific pen has enriched the Transactions of this and other kindred societies, largely illustrate as well the fossil geology of Cornwall, as other subjects of importance to the county.

The Society's proceedings of the past year have been in a great measure limited to steps for the erection of the museum so long contemplated, on which subject we beg to make the following communication for your consideration and approval:—

REPORT FROM THE COUNCIL ON THE NEW BUILDINGS.

Your Council have to report that since your last meeting, on the 7th of November, by adjournment from the 10th of October, the Building Committee have had the designs as often under their consideration as the progress in their preparations would admit. In the month of March the then intended elevation was received by the president, but as it was accompanied by no other plans, it was not in his power to take any steps for its consideration. At a meeting, however, of the Building Committee on the 27th of April, the design for the elevation, very much altered, however, by Mr. Matthews, under the instruction of the Town Council, from that which had previously been forwarded in March, was submitted for their approval, which it received; and a resolution was at the same time passed, agreeing that Mr. Smirke should be selected for its revision, in accordance with a resolution passed by

our Society. It was not, however, till the 9th of June that the plans and elevation were placed in Mr. Smirke's hands, and his remarks on the same are dated the 19th of the same month. In consequence of Mr. Smirke's remarks, various alterations were acquiesced in by the Town Council and the Public Buildings Committee, but without any consultation with your Building Committee. The result was submitted to the consideration of the three building committees, at a meeting held on the 3rd of July, but your Building Committee did not feel justified in sanctioning the alterations proposed till they had been before their Council. The necessary copies of the plans and elevations as altered were not, however, placed in the hands of your secretary till the 14th of the same month, when they were transmitted by him to the president. The circumstances of the season were such that it was impossible an effective meeting either of the council or the society, under the requisite notices, could be held for some weeks; and as the period of the regular annual meeting of the Society was approaching, it was deemed expedient the whole subject should be deferred till then. Your Council having now had the plans and elevations before them, as well as a section of the building, which, notwithstanding the delay, is not yet complete, and also having considered Mr. Smirke's remarks in relation to them, are of opinion that the amendments suggested by him should be adopted as near as possible. 1. They therefore recommend that the principal entrance should be placed on the east side instead of the west, and that the flight of steps be constructed through the whole breadth of the central building. 2. The raising the sills of the windows in the large room, so as to admit the placing of wall-cases under them, they consider ought to be adopted, but the same result may be secured by lowering the level of the floor line, which may be done with advantage to the rooms below, which are higher than necessary. At the same time they would recommend the ceiling of the same should be also lowered, it being now nearly five feet higher than the top line of the windows, which must necessarily throw the whole ceiling into dark shade. This alteration would also allow of the construction of an attic floor,

with skylight along the whole ridge, a most important arrangement for storing an extensive series of geological specimens, for the purpose of instruction, as giving a facility of inspection, and one that had been always contemplated in the accommodation to be offered by the new buildings. 3. All Mr. Smirke's recommendations affecting the front elevation they recommend should be adopted, including the width of the windows being increased to five feet, but excepting those which would remove the vertical lines, and would substitute a plain blocking course for the high attic as designed. Though believing the same would be an improvement, they are not disposed to insist on them, understanding such a change is much objected to by the other parties. They cannot, however, help pressing on the attention of all parties whether the omission of both blocking course and attic parapet would not be a great improvement as a security to the walls from damp, as well as a great saving of expense. This change, however, would involve the introduction of a pediment at the roof termination of the two wings. 4. Your Council recommend that they should have power, subject to the foregoing resolutions, to settle and arrange all minor details of change deemed necessary in maturing the plans, particularly as to offices, as well as after the working plans are completed, to enter into any contract, either separately or jointly with the other parties to the building, so that the same be carried out by public tender, and the most ample notice.

The Council have now the gratification of announcing that the site for the new museum has been munificently presented by Miss Elizabeth Carne, as a memorial of her late father, Joseph Carne, Esq., to whom our museum and Transactions were so largely indebted, and which in themselves form a never-dying monument of his ability and untiring zeal to the welfare of the Society.

Our seventh volume of Transactions has now reached the 417th page, and the Council recommend that the completion of the papers of this and the two last years shall complete it.

Mr. W. J. Henwood reports on the compiling of his valuable

researches of the eighth volume, which is entirely devoted to illustrations of metalliferous deposits. Nine large tables and 266 pages of letter-press have already been printed, but three years more are required for its completion.

The Council have much satisfaction in announcing that H.R.H. the Prince of Wales has been pleased to allow himself to be nominated the Vice-Patron of the Society, in the room of H.R.H. the late Prince Consort.

The Council recommend that application shall be immediately made to the noblemen and gentlemen who so kindly proffered their aid, for payment of their promised donations.

By order,

SAML. HIGGS, JUN.,

Assistant Secretary.

Sept. 18th, 1863.

DONATIONS TO THE MUSEUM.

1. Carbonate of Copper.
2. Fluor-spar in China-stone, from near St. Austell. By Mr. J. T. Martyn.
3. Series of specimens from Cappagh Mine, Ballydehob, County Cork.
4. Varieties of Copper, Barytes, Manganese, &c. By Capt. W. Eddy, Associate of the Society.
5. Uncleavable Fluor, from East Pool. By John Garby, Esq., Associate of the Society.

DONATIONS TO THE LIBRARY.

1. Geological Survey of India. 3 vols.
2. Geological Survey of India, on the cretaceous and other rocks of South Arcott and Trichinopoly districts of Madras.
3. Annual Report of the Geological Survey of India.
4. Report of the Geological Reconnaissance of the Northern Counties of Arkansas, made during the years 1859–60. From the United States Government.
5. Proceedings of the Literary and Philosophical Society of Liverpool. By the Society.
6. Smithsonian Miscellaneous collections. 14 vols.
7. Results of Meteorological Observations, made under the United States Patent Office.
8. Memoirs of the Society of Physics and Natural History of Geneva. By the Society.
9. Smithsonian contributions to knowledge. 3 vols.
10. Account of Mines in France.
11. Mining and Smelting Magazine.
12. Annales des Mines. From the School of Mines, Paris.
13. Journal of the Geological Society. By the Society.
14. London, Edinburgh, and Dublin Philosophical Magazine.
15. Proceedings of the Royal Society. By the Society.

TREASURER'S ACCOUNT.

INCOME.	£	s.	d.
Balance Petty Cash		4	7
Subscriptions from ordinary members and arrears (exclusive of Subscription of His Royal Highness the Prince of Wales, not yet due).....	53	11	0
Rent of Gentlemen's News Room	7	7	0
Balance due to Treasurer	41	12	3
	£102	14	10

EXPENDITURE.	£	s.	d.
Balance from 1862.....	5	1	0
Rent, Rates, and Taxes	45	8	1
Repairs, &c.	1	1	5
Housekeeper's Salary, three quarters	4	10	0
Coals	2	11	0
Insurance	3	3	6
Printing, Stationery, Periodicals, &c.	29	19	3
Advertising	2	19	6
Expenses of Secretary and Treasurer	4	5	0
Balance Petty Cash	3	16	1
	£102	14	10

TRANSACTIONS

OF THE

Royal Geological Society

OF

CORNWALL;

INSTITUTED FEBRUARY 11th, 1814.

VOLUME THE SEVENTH.

"A knowledge of our subterranean wealth would be the means of furnishing greater opulence to the country, than the acquisition of the mines of Mexico and Peru."

President of the Board of Agriculture.

PENZANCE:

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1865.

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On the Geological Age of the Dartmoor Granites.

By W. PENGELLY, Esq., F.R.S., F.G.S.,

CORRESPONDING MEMBER OF THE SOCIETY.

Though our science has risen above the stage from which she taught that all granites are parts of the original crust of the earth; though she has advanced so far as to doubt whether, in all cases, the granitic was the first phase of rock existence which the materials composing it assumed, and to entertain the question whether such rocks may not be the extreme form of metamorphism, which has obliterated all traces of an earlier condition; and though she may prudently decline to point out, in the large circle of her rocky acquaintances, one mass of crystalline un-stratified rock which, as such, can be proved to be older than some known beds of mechanical origin; still it remains to be the rule rather than the exception, to meet with persons, frequently well informed and not without an interest in Geology, who still cling to the notion, or allow it to cling to them, that every mass of granite is a primitive rock in the strict chronological import of the term, and represents a period in the earth's history prior to the possible existence of sedimentary strata or of organized beings.

Indeed the opinion that granite is, in all cases, a primary rock has so large a place in the public mind that one might prudently hesitate before throwing such a question as "What is the age of the Dartmoor granite?" before any audience having a very large admixture of the popular element.

It has long been known that the age of the granitic rocks of Dartmoor can be safely limited on the side of antiquity. That they are less ancient than the culmiferous beds of North and Central Devon has been established on satisfactory evidence, produced by various observers.

Sir Henry De la Beche, in his "*Report*," says "The intrusion "of the Dartmoor mass was certainly after the deposit of the "carbonaceous series of North Devon, be the age of that series "what it may; it thrusts the southern portion of this series "northwards to Okehampton, cuts off the ends of trappean bands "and of associated beds of grit and shale near Cristow and "Bridford, and sends veins into it in the valley of the Dart, at "the junction of the two masses of rock." *

Professor Sedgwick and Sir R. I. Murchison, in their paper on "The Physical Structure and Older Stratified Deposits of Devonshire," say "Granite veins, passing from the central mass "into the superimposed stratified rocks, are formed on all sides "of Dartmoor. We have seen them above Ivybridge, injected "amongst the oldest slates of Devonshire; and near Okehampton "we have seen them in like manner, penetrating the culm-"measures; and they are finely exposed in the beautiful gorges "of the Teign and the Dart, where those rivers descend from the "granite to the culmiferous series. These examples, to which we "could add many more, are sufficient for our purpose. Now "these veins, taken in general, are mere prolongations of the "central granite, inseparable from it, and contemporaneous with "it; they cannot therefore (as the granite is one mass) be "contemporaneous with stratified rocks of different ages. Con-"sequently they are true veins of injection, and the granite was "protruded at a time posterior to all the other stratified systems." † In another part of the same paper these authors go on to say "It appears that the rocks of Devon and Cornwall belong to "three periods of formation. The oldest includes the various "groups of slate rocks, and at least a part of the associated traps. "The next includes the culm series, the upper division of which "contains fossils identical with those in the upper division of the "coal measures. The granite belongs to the newest period." ‡

* Report on the Geology of Cornwall, Devon, &c., p. 165.

† Geol. Trans., Second Series, vol. v., part 3, p. 686.

‡ *Ibid*, p. 687.

Mr. Godwin-Austen, in his paper on the "Geology of the South-east of Devonshire," speaks also of similar granite veins, and, in a somewhat qualified manner, confirms the opinion of the authors just quoted respecting the chronology of the granite; stating that "The observation of Professor Sedgwick and Mr. Murchison "above quoted as to the age of the Dartmoor granite, applies "necessarily to that schorly portion alone which comes in contact "with sedimentary deposits, for the entire mass is not of the same "age." He then gives a figure of a section, showing "the manner "in which the usual porphyritic granite has intruded itself among "such as had already become compact and jointed and containing "schorl," and adds, "Again this prophyritic and micaceous "granite is traversed by elvans of a compact fine-grained stone, "presenting no distinct crystallization of any of its constituents, "and they have evidently been protruded posterior to the con-"solidation of the rocks in which they occur. The facts here "noticed warrant the conclusion that it" (the Dartmoor region) "contains granite of three distinct ages." *

More recently Mr. Ormerod, who most assiduously uses the facilities which his residence at Chagford gives him for the study of this subject, has mentioned several localities where granite veins occur in the carbonaceous rocks, and states that, at one place on the river Teign, "the veins throw off branches into the adjoining "rock, and vary in thickness from a thin filament to a breadth of "about 18 feet." He adds that "the veins contain portions from "the adjoining carbonaceous beds, sometimes so slightly removed "from the original position that it can be traced; in the large "veins some of the masses are rounded, as if they had undergone "attrition, but some (about a cubic foot in size) still preserve their "angularity." †

There can be no doubt, then, that the Dartmoor granites are less ancient than the culmiferous beds of North and Central Devon. Our next business is to find, if possible, a *modern* limit to their age.

* Geol. Trans., Second Series, vol. VI., part 2, p. 477.

† Quar. Jour. Geol. Soc., vol. XV., p. 192.

Amongst the stratified rocks of the county the Red Conglomerates and Sandstones, which give such a character to the cliffs and soil of South Devon, succeed, in ascending order, the Culmiferous beds already spoken of; they are the next more modern. Now Conglomerates may be regarded as natural museums in which we are likely to find specimens of all pre-existing rocks occurring in their neighbourhood; and the fact that any rock existing in a given locality has no representative fragment in an adjacent conglomerate, though merely negative evidence, would not be a bad, though by no means an unimpeachable, basis on which to found the opinion that such rock is more modern than the conglomerate thus destitute of any indication of its existence. Such an opinion, however, would, of course, be overthrown by the first fragment which further research might bring to light.

Sir Henry De la Beche says, "The evidence of the Dartmoor "granite having occupied its present relative position anterior to "the early part of the (new) red sandstone is not always so clear "as could be desired; for among all the pebbles of the red con- "glomerate extending from Torbay to Exeter, we have not been "able to detect any portion of it, though the granite ranges so "near that part of the red conglomerate. In the tongue of red "sandstone and conglomerate which runs from Crediton amid the "carbonaceous series by North Tawton and Sampford Courtney to "Jacobstow, we have, however, detected pebbles like some varieties "of Dartmoor granite." * It must be confessed that this is not a very pronounced opinion in favour of the North Tawton pebbles being of Dartmoor origin; in his paper, however, in the "Memoirs of the Geological Survey of Great Britain," the same author speaks of them in a somewhat more decided tone, as follows; "Among "the pebbles of the new red sandstone conglomerate nearest to "Dartmoor, granite from it is scarce, some varieties having been "only found on the north by Tawton and Sampford Courtney." †

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* Report of Cornwall, Devon, &c., p. 166.

† Memoirs Geol. Survey, vol. I., p. 228.

Geologists, however, have by no means all concurred in this opinion respecting the so-called "granite pebbles:" thus we find Mr. Godwin-Austen—and probably few geologists are so intimately acquainted with the district,—in his paper already quoted, expressing himself thus: "In the study of detritic formations, the identification of mineral fragments becomes of almost "equal importance with that of organic remains; in the present "instance they afford only negative testimony; but as, from the "absence of volcanic fragments in the conglomerate eocene beds "of Central France, we infer the relative age of the volcanic "outbursts of that region, so, as no granitic pebbles have been "found among the various materials of which the new red "conglomerate is composed, we may conclude, that at the period "of its accumulation the granite of Dartmoor could not have "been exposed, particularly when we bear in mind that the two "formations are at present separated only by the valley of the "Teign.

"The beds of the greensand of the Haldons and the Bovey "valley, in the thin mica, sharp quartzose crystals and seams "of felspar clay, suggest that they may have resulted from a "decomposed granitic district; but here again, although fragments "of all the older rocks occur in the conglomerate beds at the base "of the greensand, granitic pebbles are altogether wanting; nor "do we meet with them until we arrive, in ascending order, at "those superficial accumulations which cap the Haldons, when "they appear in great abundance associated with rolled flints, "and worn like marine shingle. Possibly, then, the rise of the "granite of Dartmoor in its present form may belong to a period "comparatively recent." *

Sir Charles Lyell says "The granite of Cornwall is probably "of the same date" (as that of Dartmoor), "and therefore as "modern as the carboniferous strata, *if not much newer.*" † This expression is clearly very guardedly indefinite, much more so,

* Geol. Trans., Second Series, vol. VI., part 2, p. 478.

† Manual, 5th edition, p. 587.

probably, than would have been the case had that distinguished author been satisfied that the pebbles in question were really granite. Happening a few years ago to be at North Tawton, I mentioned the subject to Mr. Wm. Vicary, then resident there. He immediately took me to the conglomerate and, in a few minutes, extracted two or three pebbles which both of us regarded as certainly of Dartmoor derivation. I am not sure that either of us would have contended that they were true granite, if by that term we are to understand a mass made up solely of distinct crystals of felspar, quartz, and mica; nor, thus defined, would any one be prepared to call everything granite which occurs in the true Dartmoor country. Sir Henry De la Beche says "The "granite of Dartmoor is, as a whole, a coarse-grained mixture of "quartz, felspar, and mica, the latter sometimes white at others "black, the two micas occasionally occurring in the same mass. "It is very frequently porphyritic from the presence of large "crystals of felspar, and here and there schorlaceous, but the "latter character is chiefly confined to the outskirts where the "Dartmoor granite adjoins the slates. The schorl not unfrequently "occurs in radiating nests of variable size and abundance. A "complete passage may generally be traced between the compound "of schorl and quartz, usually termed schorl rock, and the "ordinary granite. The mica usually disappears as the schorl "begins to be abundant, and sometimes, though not very commonly "beyond limited areas, the granite is a mixture of mica, schorl, "felspar, and quartz, in nearly equal proportions. After the "absence of mica the next mineral which commonly disappears is "the felspar, leaving the compound a mixture of schorl and "quartz, the former sometimes occurring in radiating nests in the "latter, but more commonly the two minerals form an aggregate "in nearly equal proportions." * This though a comprehensive, is by no means an exhaustive, description; considerable dissimilarity exists in the size of the aggregated crystals in different specimens;

* Report of Cornwall, Devon, &c., p. 158.

nodules, apparently segregative, sometimes occurring in the substance of the ordinary granite, might, from the fineness of their grain, be almost mistaken for sandstones; indeed I, not long since, heard them appealed to as a proof of the metamorphic origin of granite. "Here," said the appellant, "are unaltered remnants "of the old sandstone beds which, with these exceptions, meta-"morphism has converted into granite." I do not quote this for the purpose of endorsing it, but simply to show the general dissimilarity of the nodules to granite proper; excepting their darker colour, they reminded me much of the granitic veins passing through the older granite of Goatfell in the isle of Arran; nevertheless they are not veins but nodules, and capable of being extracted, as such, from the granitic mass containing them. Elvan dykes, similar to those mentioned by Mr. Austen in the passage already quoted, occur within a couple of miles of the spot where I extracted the nodules spoken of; but are unlike them in colour and general texture. The latter are composed of very fine grains of quartz and schorl in nearly equal proportions.

The observer who enters a Dartmoor quarry soon discovers that granite is by no means weather-proof; the effect of the weather is very discernible fully a foot or more within the exposed surfaces. A more or less dark or ferruginous looking border, of about the width just mentioned, graduates into the unchanged rock, and suggests that small fragments might, through long-continued exposure and rough usage, undergo a very considerable change of aspect.

The boulders which occur abundantly in the beds of the Dartmoor rivers and rivulets are found to be more or less changed in character; were it not that every gradation can be readily supplied, it would sometimes be, at least, a little puzzling to recognise a member of the Dartmoor family of rocks in the fragments met with along the river courses, and which have yielded to the various influences to which they have been exposed since leaving home. It is these travelled masses which must tell us whether the red conglomerates of Devonshire contain specimens

derived from its central upland; and I have no hesitation in believing that every one approaching the subject thus would pronounce the North Tawton pebbles to be of Dartmoor origin.

In August last (1861), I met Mr. William Vicary, who now resides at Exeter, and is devoting himself, most diligently and successfully, to the geology of the neighbourhood, and again introduced the subject of the North Tawton pebbles, on which he informed me that he had recently found unmistakeable Dartmoor fragments in the red conglomerate of Great Haldon, a well-known hill about five miles south of Exeter; and that a friend, to whom he had mentioned his discovery, had called his attention to the following passage in Brice's "History of Exeter." The author is describing the red conglomerate of Haldon, and says, "In it "we have often found rounded pebbles and pieces of granite of "the same form." * A fact of so much interest was not to be neglected; accordingly we took an early opportunity of starting for Haldon. Passing through Alphington and Kenford, and leaving the great road from Exeter to Plymouth, by Chudleigh and Ashburton, on the right, for that which passes over Haldon, in a more easterly direction, to Newton Bushel, we reached our ground about five miles and a half from Exeter; and Mr. Vicary at once pointed out one or two well-marked fragments of the true Dartmoor series of rocks in the conglomerate, but so far decomposed and disintegrated that it was impossible to extract them in their integrity; a further search was soon rewarded with several less perishable specimens, and amongst them representatives of each kind of granite recognized by Mr. Austen in the Dartmoor country; namely, schorlaceous granite, porphyritic granite, and elvan.

On our way back to Exeter we detected two or three well-marked specimens near Peamore, about two miles and a half from the city.

That part of Haldon at which the pebbles are met with is about five miles, in a straight line, from the nearest point of

* History of Exeter, by Thomas Brice, 1802, p. 114.

the granite district. The fragments found near Peamore must have travelled something more than a mile farther. The red conglomerate approaches to within about the same distance from the granite at Newton Bushel and several other places. The fact, if it be one, that no such pebbles have been found in these localities should stimulate to further and careful search; and if, after all, they really do not exist there, it need not be a matter of very great surprise; changes in the physical geography of the district, amply sufficient to account for it, may have occurred since the period of the red conglomerates. I may state here that during the spring of the present year, Dr. Daubeny pointed out to me certain pebbles which he thought granite in the red conglomerate at Livermead in Torbay; my own impression however is that they are fragments of porphyritic trap. I do not, of course, suppose that my opinion would be of any value when opposed to that of the eminent man just named, especially on a point of this kind. I merely mention the fact to show that I have not allowed a strong bias, supposing me to have one, to overrule my judgment, or I should have quoted the Livermead pebbles as granitic on Dr. Daubeny's authority. But waiving this point, I cannot regard it as certain that the red rocks of Torbay and of the South Devon coast generally are entirely destitute of Dartmoor detritus. Every one who has paid attention to the sandstones there must be well aware that, in many cases, they are eminently micaceous; this is very noticeable at the Corbons and at Livermead Head in Torbay, where every newly-exposed surface glistens, with an almost metallic glance, from the presence of numerous large scales of black mica, doubtless a result of the destruction of a large amount of pre-existing rock of which mica was a constituent. It is, no doubt, true that certain gritty members of the older rocks of the county sometimes contain scales of mica; it seems impossible, however, that these can have been the source of those found in the red-sandstone, for, so far as I am aware, they are always small instead of large, and invariably white instead of black; whilst, on the other hand, Sir Henry De la Beche, in a

passage already quoted, tells us that the mica of the Dartmoor granite is frequently black. Nor is it difficult to understand that whilst boulders and pebbles might be unable to force a passage to, what is now, the South Devon sea-bord, comparatively small thin flakes of mica succeeded in accomplishing the journey.

If it be true that granite pebbles occur at Sampford Courtney, North Tawton, and Haldon, that is, north and north-east of Dartmoor, but do not exist on the eastern side of the same region, may we not have in this fact an indication of the prevailing direction of the most powerful currents or other agents of transportation in this part of modern Devonshire during the red sandstone era?

The following appears to be a strikingly parallel case. The low plain known as Bovey Heathfield, in Devonshire, is covered with a very coarse gravel; and is surrounded on almost every side by hills of considerable elevation; on the north and west, Dartmoor granite fringed with traps and metamorphosed rocks; on the north-east, Haldon and other flint localities; and on the south, Devonian limestone and associated rocks. The Bovey gravel is composed of Dartmoor and flint debris, the former *very greatly preponderating*. I will not undertake to say that it contains no fragments of limestone, but certainly I never saw or heard of one, though, during the past twelve months, I have frequently, and with considerable care, examined the gravel, and questioned the men who work amongst it, with reference to this point. Yet the limestone is older than either of the other rocks I have named. Accepting this negative evidence, as trustworthy, it simply proves that the direction of transportation was not from the south; not that the rocks in question have been called into existence since Bovey plain received its surface covering.

But to return. The facts now in our possession appear to compel the belief that the Dartmoor granites were not in existence when the culmiferous rocks were deposited, but did exist and were exposed at the surface of the earth in the conglomerate era. In relation then to the stratified rocks of the county we have both an ancient and a modern chronological limit for the granites. Our

next question is, What are the places of these "limiting" rocks in the chronological series of the geologist?

There is no difficulty in furnishing an answer with respect to the *ancient* limit,—the culmiferous beds. Professor Sedgwick and Sir R. I. Murchison, in their paper already quoted, say, "The "*flora* of the upper culms, as far as it has been ascertained, "agrees specifically with the known *flora* of the Carboniferous "period. We think we have strong direct evidence to establish "our position that the upper culm strata of Devon are the "geological equivalents of the ordinary British coal fields." * The same authors state, in a passage previously quoted, that "the "upper division of the culm series contains fossils identical with "those in the upper division of the coal measures."

It is not so easy to settle the chronology of the *modern* limit,—the red sandstones and conglomerates. That they belong somewhere between the Carboniferous and Jurassic systems there can be no doubt, since they overlie the culmiferous beds and pass under the Lias; but whether they are Triassic or Permian has not been considered so certain as could be desired. They are entirely destitute of fossils excepting those only which occur in the pebbles, which, of course, belong to the age of the parent rocks. The sandstones were evidently of littoral origin; their surfaces frequently display *wave* ripple-marks, sun-cracks, and impressions of rain-drops; but no footprints or other organic traces have ever been detected on them; they seem to contain no palæontological indication whatever as to their age.

More than one eminent geologist has been struck by the angular character of the fragments composing the conglomerates,—more correctly breccias—and has remarked that, in its physical character and general appearance the formation is rather Permian than Triassic. It is, as is well known, coloured, in our geological maps, as being on the horizon of the Lower Trias; I am not without hopes that the granite pebbles, so frequently mentioned here, may help to show that it is not older than this.

* Geol. Trans., Second Series, vol. v. part 3, p. 682.

Whatsoever may be our opinion respecting the origin of granite, —whether we hold it to be a strictly igneous, or thermo-aqueous product,—an original or a superimposed phase of rock existence,— we are all agreed, probably, that it was formed in Plutonic depths; a hypogene formation requiring, for its elaboration, enormous pressure and, therefore, at least, commensurate resistance in a superincumbent crust. In the case before us the overlying mass existed at the close of the carboniferous period, or the granitic form could not have been assumed by the Dartmoor rocks; and it must have been removed and the granites laid bare before the conglomerate era, or fragments of the latter could never have found their way to Haldon.

Mr. Sorby estimates the pressure under which the St. Austell granite was formed as equivalent to that of 32,400 feet of rock, that of the mean of the Cornish granites at 50,000 feet, and that of Ding Dong mine near Penzance at 63,000 feet.* He gives no estimate for Dartmoor, but taking the *lowest*, his St. Austell, figures we have a pressure equivalent to that of a pile of rocks six miles in thickness; but since the pressure was probably due to the expanding power of some agency acting beneath, or within, the granitized mass;—requiring resistance and not pressure, strength and not weight, in the overlying crust,—we will content ourselves with a small fraction of this; nevertheless there must have been a solid crust of great thickness, for Denudation to strip off before a granite pebble could travel to Haldon.

Even if we suppose that some paroxysm uplifted the granite in a solid state, so as to shiver the overlying masses and, thereby, facilitate the work of denudation, still the removal of such a mass of rock must have required an amount of time so vast that it seems totally impossible to regard the red conglomerates and sandstones as more ancient than the lower Trias; and, even thus, what an incalculably great value does this stamp on the units of geological chronology!

The supposition, however, that the granite was thus thrust

* Quar. Jour. Geol. Soc., vol. XIV., p. 453, &c.

through the overlying rocks is altogether improbable, for the latter appear to have shared in all the great movements which the former may have undergone. According to Sedgwick and Murchison the granite veins in the older surrounding rocks, "taken in general, *are mere prolongations of the central granite, "inseparable from it,* and contemporaneous with it." *

The time of denudation, moreover, vast as it probably was, formed but a fraction of the period separating the culmiferous and red rocks. At the close of the carboniferous period there was no Dartmoor granite; after this we have, according to Mr. Godwin-Austen, the formation of three distinct masses of granitoid rocks, very distinguishable from one another, clearly results of dissimilar conditions within the same area, and, therefore, referable to different times. The *schorlaceous granite* was first formed; this was succeeded by the *porphyritic* variety when the first had become compact and jointed; afterwards the *elvans* were formed and obtruded into the porphyritic mass subsequently to its consolidation; † then followed the period of denudation: but all this was anterior to the commencement of the conglomerate era, since pebbles of each kind of granite occur in the Haldon beds, which belong to the base of the red rocks of Devonshire.

Should it be objected that the granites, though requiring great pressure, were not necessarily formed beneath an accumulation of *rocky* matter, but possibly under an equivalent depth of sea; it does not appear that this can greatly affect the chronology of the question, at least, by way of abridgment. Passing by all other considerations, we should require a lapse of time sufficiently great to carry down the area of, at least, Central Devon, from the relatively high level at which the culmiferous beds were certainly deposited, to an ocean depth of enormous profundity; and time enough too, after the Plutonic masses had, at this depth, been called into existence, to bring it up again within the influence of the waves, so that they might detach samples, of each variety of granite, to be transported to where the conglomerate was being formed.

* Geol. Trans., 2nd series, vol. v., part III., p. 686.

† Geol. Trans., 2nd series, vol. VI., part 2, p. 477.

Take what view of the case we may, an enormous period between the culm and conglomerate series appears inevitable; a period during which great changes were effected within, and on, the crust of the earth,—changes which, from their nature, could not have been contemporary, but must have followed each other in a definite and ascertained order, and the greater part of which, at least, Convulsion or Catastrophe must have been powerless to produce or hasten.

Unless we assume that a great chronological interval elapsed between the Carboniferous and Permian periods,—and to this Palæontology appears to give no sanction *—the facts of the case seem to require the belief—

1. That the granites of Dartmoor are not older, at most, than the close of the Carboniferous period.

2. That they had been stripped bare by denudation when the materials of the red conglomerates were being brought together.

3. That the red conglomerates and sandstones are not of higher antiquity than the Trias. But whether they belong to the Lower or to the Upper division of this formation, that is, to the Bunter or to the Keuper, it may not, at present, be easy to determine.

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* Page's "Past and Present Life of the Globe," p. 114.

Enquiry into the Age of that part of the District of the Maritime Alps which surrounds Mentone.

By MISS E. CARNE,

MEMBER OF THE SOCIETY.

If we look at a sketch of the neighbourhood of Mentone we shall see three prominent features in the landscape—1st, rocky cliffs and mountain ridges and peaks; 2nd, steep mountain slopes, often much shattered and seamed, with wastes of grey rubbish appearing through the rich cultivation of lemon and olive groves; and amidst these wastes and groves, a broken line of rock forming a low escarpment on the hill-side; 3rd, a series of hill-ridges singularly alike in their direction (nearly north and south), in their average elevation, and in the general contour of their surface, and of the beautiful valleys that separate them.

These external differences are coincident with differences of structure and mineral composition. The rocky cliffs and mountain peaks are limestone of a pale buff or cream colour, very hard and crystalline, and in most cases without any trace of structure; the dip of the beds, therefore, cannot be positively ascertained. The only place near Mentone where some sort of dip is discernible is in those masses of rock which stand just above the sea beyond the point called the Red Rocks:—here the crystalline limestone seems to dip somewhere between north and east; and the same direction may be observed in many parts of the road between Mentone and Nice. Perfect fossils are not common in this formation, but around the Red Rocks traces of them are abundant.

The slopes which descend from these mountain peaks are chiefly composed of beds of pale blue marl, distinctly marked by the nature of its fracture—half globular, half angular—which is visible even in the minutest fragments. Layers of calcareous spar occur

in this marl, from a quarter of an inch to some inches in thickness and from one to several feet apart. It contains also bands of a very tough sandy limestone; and these bands commonly become more frequent in the higher parts of the mountain-slopes until the blue marl almost disappears in a succession of gritty limestone courses, from half a foot to two or more feet in thickness. All this formation, as far as I have traced it, dips towards the north and east. It passes under great part of the brown sandstone surface of the Cemetery Hill. I believe it forms part of the bed of the stream in the Mentone valley, and it reappears beyond the Gorbio torrent on the hill road to Roccabruna, still dipping to the north and east. It is generally too soft to preserve any organic remains, but fossils are found in some localities.

The low escarpment which appears among these blue marl beds on the mountain-side, is the edge of a broad band of nummulitic limestone from 20 to 40 feet thick. This also appears capping the hill above Grimaldi, as far as the Croce de Mortola; and, in the valley that debouches at the Pont St. Louis, another escarpment may be seen running far up on the eastern side of the stream. I have never closely examined this latter bed, but, from its external resemblance to that on the Mentone side of the ridge, I have no hesitation in pronouncing it to be a band of nummulitic limestone. This formation is, internally, a hard dull blue rock, which towards the surface, becomes brown and more or less soft, until it wholly crumbles away, leaving the nummulites with which it is loaded strewed like pebbles on the mountain paths. It dips towards the north and east conformably with the blue marl beds that lie above and below it. I must add that fragments of nummulitic rock lie on the east and west flanks of the ridge that descends from the Berceau to the Pont St. Louis, far above any nummulitic beds which I have been able to discover.

The four hill-ridges to the west of Mentone are of very coarse sandstone, the beds of which on the Cemetery Hill dip sharply to the south and west. Just behind the new church they are almost perpendicular. There is a small patch of this sandstone on the

flank of the Berceau ridge (rather below the nummulitic escarpment) which dips to the north and east; and there is another patch enclosed in a lemon garden, but jutting out on the beach beneath the wall of enclosure, a little west of the torrent of St. Louis. I have never found any fossils in this sandstone.

Now what is the age of all these formations? The answers, even from experienced geologists, have been so various, that we must suppose—either that their observations have been imperfect, not to say incorrect, or that this district of the Maritime Alps furnishes an instance of gradual succession from the *Oolite* to the *Eocene* inclusive, where one geologist has found fossils characteristic of one formation in beds not clearly separable from those where another geologist has found fossils characteristic of another. De la Beche, in vol. iii. of the Geological Transactions, refers the light-coloured limestone of Pont St. Louis to the *oolite*, and the coarse brown sandstone, the grey marl, and the nummulitic limestone to the greensand. He also includes in this formation a "marno-arenaceous limestone, containing *Inoceramus* and *Hamites*, and a light-coloured limestone with green grains." Dr. Buckland, in the same volume, agrees with the latter conclusions, but thinks it possible that some of the light-coloured limestone of Nice (identical with that of the Pont St. Louis) may belong to the new red sandstone. Professor Perez, in the Quarterly Journal of the Geological Society (vol. ii., part 2, Miscellaneous), and Major Chartres, in the same volume, come to the conclusion that the nummulitic bed must be classed as intermediate between the chalk and the tertiary, or rather "that it should be united with the tertiary series as a lower member and quite detached from the chalk." Professor Perez finds at Mortola the nummulitic strata resting upon "a bluish marly limestone, with *Inocerami* and *Hamites*, and without a trace of nummulites," which he regards as representative of the chalk: and "at the geographical limits of this formation (he does not say where) two strata of sandstone more or less green crop out," which he refers to the greensand: while the light-coloured limestone on which they rest, belongs, as

he thinks, to the *Oolite*. He bases all these conclusions on the fossils found in the different formations. Lastly, it appears from Professor Perez's allusions to Sismonda and Pareto, that these observers regard the nummulitic beds as the upper, and the compact light-coloured limestone as the lower, members of the cretaceous series. This receives some confirmation from the fact that all the fossils I brought from Mentone, whether found in the nummulitic bed or in the light-coloured limestone, were submitted to Mr. Etherege, of the Jermyn Street Museum, and were by him pronounced to be all cretaceous.

The evidence derived from mineral composition, relative situation, and common direction and dip, bears out the latter opinion. Even when the mineral composition seems most unlike—as in the soft blue marls and the hard buff-coloured limestone of Pont St. Louis, there are some facts which seem to imply a connexion between them. The Pont St. Louis limestone is said to be poor in fossils, but in turning over the heaps of fragments which lie on its slopes, I early noticed certain curious curved lines which were too frequent, and too little like crystalline structure, to be always referred to the irregularities of calcareous spar. But when my eye became accustomed to the curves of the nummulites, and to their gradual disappearance in the most crystalline part of their own bed, I perceived that these curved lines in the limestone of Pont St. Louis closely resembled the outlines left by nummulites when partially obliterated. The best way to detect this is to go to the large masses of rock which lie around the ruined oil-mill near the sea, a little beyond the Red Rocks. Oval forms, much resembling nummulites, are there abundant and tolerably plain, being brought out by the weathering of the rocks. Then if we turn and examine the rocks as we go westward we shall find that these outlines become less and less plain, until indistinct curved lines alone remain. I have found these faint outlines in fragments and *in situ* all around and above the Pont St. Louis, but have looked for them in vain on any other part of this mountain ridge. But I think it is evident that their rarity is simply due to

obliteration. We must, therefore, regard this great mass of light-coloured limestone as, in some degree, a metamorphosed rock which still retains faint traces of organic forms, closely resembling partially-obliterated nummulites, though I am too ignorant of fossils to venture to say that these are actually nummulitic forms.* This limestone is now chemically different from nummulite limestone, containing much more iron, as is evident from the rust-red colour of the soil derived from it; but whether this excess of iron existed in the limestone previous to the change which destroyed its organic remains, or whether its introduction was part of that change, it would be impossible to say.

The nummulite limestone itself is nothing more than a broad belt amidst the blue marl beds that lie above and beneath it—alike in direction and dip, and much alike in mineral composition; for the calcareous matter which, from some unknown cause, forms distinct bands in the blue marl, seems to have been more equally distributed through the nummulitic beds, producing an uniform hard dull blue limestone.

So also, the coarse sandstone of the Cemetery Hill and the hill-ridges beyond it, seems to have been a deposit gradually wedging out between higher and lower blue marl beds. At present it is so manifestly upset and tilted that I was at first quite at a loss where to look for its original position; but a scramble up a little torrent-bed that lies on the hill-side in a direct line between the mouth of the Garavan and the peak of the Berceau seemed to settle that difficulty. I found a band of this coarse sandstone above some beds of blue marl, and below other beds of blue marl, the latter being themselves below the great nummulitic bed. And, moreover, the dip of this sandstone was directly opposite to that on the Cemetery Hill:—there it dips sharply to the west and south; here, half a mile off, it inclines somewhat less sharply to the east and north. Between them lies the great fracture of the Garavan torrent-course; and it is scarcely

* I must add that Mr. Etherege has pronounced some of these curved lines to be corals.

possible to escape the conclusion that those ranges of sandstone hills to the westward are the continuation of this narrow band on the south flank of the Berceau, fractured and upset.

This coarse sandstone seems to have some affinity to the English greensand. Yellowish and greenish limestone is found on its borders in the torrent of the Gorbio valley: a green band appears in it on the beach near the torrent of St. Louis; and fragments of green sandstone are found in a great dry ravine east of the Garavan.

None of these formations rest upon the central ridge of light-coloured limestone. On this point De la Beche's map gives a wrong impression, as he has represented all the beds on the south-west flank of the ridge as dipping outwards from it instead of dipping inwards towards it. But the underlie of this pale limestone is seen on the other side, beyond the Red Rocks, where the blue marl beds manifestly rest upon it. Here, also, we observe that the coarse sandstone has wedged out and disappeared. If we take it for granted (as I suppose we must do, without any proof to the contrary) that the blue marls, capped by nummulitic limestone near Cap de Mortola, are a dislocated and upheaved portion of the blue marls, covered by nummulitic limestone on the south-west side of the dividing ridge, we shall, by comparing them together, obtain this order of position:—

Lowest of all—light-coloured limestone of Pont St. Louis.
Lower blue marl beds.
Beds of coarse sandstone—having some affinity to the greensand.
Middle blue marl beds.
A broad band of nummulitic limestone.
Upper blue marl beds—passing into a series of gritty sandy limestone courses.

All these formations lie on each other conformably (that is, as far as we can discern any structure in the lowest limestone) all dip towards the east and north; all share in the great fractures which have broken up the surface of the country; whilst the frequent re-appearance of the blue marl beds intimates a tranquil oscillation

of causes and repetition of effects, which could only belong to a comparatively undisturbed condition of the external agencies which have influenced the deposition of all these strata.

But *since* their deposition, great disturbances have occurred. The whole ridge of the Berceau has been elevated 1500 or 2000 feet, and the whole district is crossed by great lines of fracture which clearly prove that the elevation was neither gentle nor uniform. And we know that these disturbances took place prior to the deposition of the later tertiaries at Savona, Alberga, and Nice, for in all these instances the more modern beds are not conformable with the more ancient ones, but are found either lying horizontally on their tilted edges, or dipping in an opposite direction.*

When, therefore, Sismonda and Pareto affirm that all the deposits of this district form part of the cretaceous series, the circumstances of their original deposition and present position seem to confirm the assertion. Their apparent connexion in a mineralogical point of view is in harmony with their connexion in a palæontological point of view: while the disturbances subsequent to their deposition which have separated them from beds undoubtedly tertiary, is in harmony with that great change in organic life which marks the transition from secondary to tertiary strata.

On the other hand, when Professor Perez draws a sharp line of separation between blue marly limestone with nummulites and blue marly limestone with *Inocerami* and *Hamites*, with blue marl beds above them and blue marl beds below them, all closely related in composition and direction, his theory introduces a great change of organic life into the very middle of the beds so peaceably connected by mineralogical relations. According to him *Eocene* have succeeded cretaceous deposits without any marks of disturbance in the circumstances of their deposition, whilst a far less change—that, namely, from the *Eocene* to the *Pliocene*

* Lyell's *Prin.*, Book IV., ch. 12.

has been marked by a series of convulsions which has broken up the surface of the whole country.

It would be folly to place considerations like these in opposition to certain evidence derived from fossils, but as that evidence is at present so incomplete as to seem equally strong on both sides, these facts are brought forward simply to show their agreement with one view, and their disagreement with the other.

On the Co-relation of the Slates and Limestones of Devon and Cornwall with the Old Red Sandstones of Scotland.

By W. PENGELLY, Esq., F.R.S., F.G.S.,

CORRESPONDING MEMBER OF THE SOCIETY.

The distinguished author of "*Siluria*," as geologists are well aware, has made a tripartite division of the slates, limestones, and associated rocks of Devon and Cornwall, as well as of the Old Red sandstones of Scotland, South Wales, &c.; and has given chronological equivalency to the lower, middle, and upper groups of each respectively. Thus, he places the Barnstaple and Petherwyn beds—the latter characterized by the presence of *Clymenia* and *Cypridina*—on the horizon of the Upper Old Red, with its *Holoptychius* and *Phyllolepis*; the deposits of Caithness, &c., containing the remains of *Coccosteus* and *Asterolepis*, are made to synchronize with the limestones of Torquay, Newton, Plymouth, &c., in which are found *Stringocephalus, Calceola, Bronteus, Acervularia*, &c.; whilst the Lower Old Reds of Forfar and the North-east Highlands, with *Cephalaspis, Pteraspis, Onchus*, &c., are regarded as the equivalents in time of the slates of Meadfoot in South Devon, and Looe, &c., in Cornwall, well known to contain the remarkable coral *Pleurodictyum problematicum*, &c.* Though this co-ordination may be said to have met with a large acceptance, it is not in keeping with the opinions of some who laboured long and sedulously amongst the older rocks of the two south-western counties of England; nor is it unchallenged by existing writers. The late Sir Henry De la Beche regarded "the bulk of the Devonshire and Cornish rocks as, at least, in part equivalent to the lower beds of the carboniferous limestone, to the passage beds between the old red sandstone and carboniferous

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* "*Siluria*," Third Edit., p. 433, 1859.

limestones of Ireland, South Wales, &c., and also to some portions of the higher parts of the old red sandstone of Herefordshire and adjacent districts;"* whilst the Rev. David Williams considered "the Devonian system as occupying an enormous interval between the old red sandstone and mountain limestone."† That some—that much diversity of opinion should exist respecting the time relations of the two systems of rocks now under notice, is what might be expected when we remember their lithological and palæontological dissimilarity; the northern beds are eminently arenaceous, whilst those in the south are almost exclusively argillaceous or calcareous; the former teem with fossil fish, and the latter with the exuviæ of molluscous and radiate animals; but, according to our fossil registers, Scotland does not yield the shells, corals, or sponges so abundant in Devonshire, nor are the ichthyolites of the former found in the latter area. It will doubtless be remembered, however, that, in his "Palæozoic Fossils of Cornwall, Devon, and West Somerset," Professor Phillips has figured and described a fossil found in the slates of Meadfoot near Torquay; and which he regarded as a scale of *Holoptychius*.‡ It would seem that this identification has not been considered to be perfectly trustworthy, since the fossil has not found a place in Professor Morris's "Catalogue of British Fossils." This dissimilarity of the organisms of two almost adjacent and, as has been supposed, contemporary sets of deposits is, to say the least, very remarkable. The mineral character and mechanical condition of the Old Red rocks may sufficiently explain why they do not contain molluscs or other dwellers at the sea bottom, but there seems no satisfactory mode of accounting for the non-appearance of fishes in the slates and limestones of Cornwall and Devonshire. Various solutions of the problem have been attempted: we are asked by one to suppose that some geographical difficulty or barrier separated the two areas, and prevented the migration and mingling of their inhabitants; whilst another suggests that the Old Red

* "Memoirs Geol. Survey," vol. I., p. 103, 1846.

† "Trans. Roy. Geol. Soc. Cornwall," vol. VI., p. 123, 1846.

‡ "Palæozoic Fossils," Pl. LVII., Fig. 256, p. 133, 1841.

fishes were at home in fresh water only, and ought not to be looked for in beds so decidedly marine as those of Devon and Cornwall. The interesting and important discovery, by Sir R. I. Murchison, of the intermixture in the same Devonian bed in Russia, of the fish of the Upper and Middle Old Red of Scotland, with the shells of Devonshire, leaves the difficulty untouched. Nor does it appear that the synchronism of the two sets of representative beds in Britain necessarily flows from it. It proves, of course, that the fish and shells lived at one and the same time in Russian, but not that they did so in British, waters. We may have here an instance of the distinction between geological *contemporaneity* and *homotaxis*, so ably pointed on a recent occasion by Professor Huxley.* It is possible, for example, that the fish commenced existence before the shells, that they lived in Scotland long before their descent upon Russia, that slowly changing conditions compelled them tardily to abandon their earlier home for one more congenial, and that, on their arrival there, they found the invertebrate tribes which subsequently migrated to where the foundations of the future Devon and Cornwall were being laid. Be this as it may, geologists have from time to time believed that no sufficient reason has been assigned for the absence of the Old Red fishes in Devon and Cornwall if the two systems of deposits really synchronise; and at intervals we have heard that at length the wished-for ichthyolites have been exhumed in the southern area. At the meeting of the British Association held at Cork, in 1843, Mr. Peach brought under the notice of the geological section certain fossils which had then recently been found by Mr. Couch in the Devonian slates near Polperro, in Cornwall. The palæontologists to whom they were then submitted considered them to be fishes; and indeed the late Mr. Hugh Miller subsequently found among them a specimen of which he said that, "If he had found it in the Old Red Sandstone of Cromarty, he would have no hesitation

* Quarterly Journal Geol. Society, vol. 18, p. xlii. 1862.

in regarding it as a fragment of some dermal plate of *Asterolepis*." They were afterwards subjected, by Professor Mc Coy and Mr. Carter, of Cambridge, to a rigorous microscopic scrutiny, and pronounced to be nothing more than sponges, belonging to their new genus *Steganodictyum*, of which they formed two species. It may be doubted, however, whether certain fossils found in the same beds are not true ichthyolites; indeed, one specimen which a few years ago I found in the *Steganodictyum* beds at Looe has been pronounced by Sir Philip Egerton and others to be a decided ichthyodorulite. It has not been identified, however, even generically. I have reason to believe that this is by no means the only defence spine found in the same beds. A few weeks since I had the good fortune to find a fossil in the *Pleurodictyum problematicum* slates at Meadfoot, near Torquay; that is in certainly the lowest group of the Devonian rocks of South Devon and Cornwall, and which Sir R. I. Murchison has placed on the horizon of the *Cephalaspidian* and *Pteraspidian* beds—the lowest of his divisions of the Old Red of Scotland. From the first I believed my fossil to be a fish scale or plate; and, very recently, Mr. Davies, of the British Museum—to whose opinion on palæontological questions, recent discoveries have shown that much deference must be paid,—has identified it as an unmistakeable scale of *Phyllolepis concentricus*, a fish known only by its fossil scales, and which in Britain has hitherto been found only in the Clashbennie beds, which belong to the Upper Old Red of Sir R. I. Murchison. This fossil then appears to necessitate the belief either that the organism which it represents had a greater vertical range than has been previously supposed,—that is, that it belonged to the Lower as well as to the Upper Old Red fauna; or that the *Pleurodictyum* beds of Devon and Cornwall, instead of being on the horizon of the Lower, are on that of the Upper Old Red of Scotland. To accept the first of these, apparently the only two, alternatives, would be to accept the difficulty of supposing that *Phyllolepis* was in existence with the organisms of both the Lower and Middle, as well as the Upper, Old Red groups, and yet that it failed to leave behind it any traces of

its existence save only in the last, notwithstanding the proved capability of the earlier groups faithfully to preserve such interesting remains. Rejecting this hypothesis, however, we seem compelled to adopt its rival, which amounts to this: there are in Devon and Cornwall no representatives of the Lower and Middle Old Red rocks of Scotland; but the Lowest, the *Pleurodictyum*, beds of the former area are on the horizon of the Upper division of the latter,—an opinion in harmony with that of Sir Henry De la Beche, already quoted. I may remark here that in a paper which I read before the Society in 1860, and which was printed in the Report for that year, I stated, on the evidence of the statistics of the invertebrate fossils of Devon and Cornwall—considered both specifically and generically—that there were in South Devon no deposits chronologically equivalent to the Lower Old Red Sandstones; and that the Barnstaple beds were rather Carboniferous than Devonian, or were perhaps "Passage beds" between the two. It is not without interest to find that the new and better evidence, as being vertebrate, harmonizes with this opinion. The *Phyllolepis* scale I have mentioned was found in a stratum rich in corals and brachiopods; the fish to which it belonged was, consequently, not incapable of living in the sea. It will not be out of place to remark here that its locality was that of the *Holoptychian* scale mentioned by Professor Phillips.

On the supposed Uniform Height of Contemporary Raised Beaches.

By W. PENGELLY, Esq., F.R.S., F.G.S.,

CORRESPONDING MEMBER OF THE SOCIETY.

In a paper by Miss E. Carne, on "Cliff Boulders in the Land's-end District," read before the Society at the annual meeting in 1860, and printed in the Report for that year, the author calls attention to certain supposed "characteristics which would mark our existing beaches, if an elevation of land raised the whole district from 10 to 40 feet," and states that "a general movement upwards would produce some sort of uniformity in the height attained. Raised beaches might be 10 feet above high water at Penlee, and 40 feet at the Land's-end; but then we should expect to find them at intermediate heights at intermediate places —not 10 feet at one place and 20 at the next and 10 again at the third. This could only be caused by separate upward movements, which could have scarcely failed to disturb and shatter the surrounding rocks."

My present intention is not to consider the correctness, or otherwise, of the views put forth by the author respecting the origin of the cliff boulders, but to call attention to what appears to me a fallacy in the passage just quoted.

I understand a modern sea beach to be an accumulation of rolled rock detritus, with or without marine organic exuviæ, not necessarily covered by very high water or exposed by each receding tide, and therefore, not necessarily reaching the same level in every part of the same district.

To illustrate my meaning I will confine myself to the Torbay district, with the tides of which I am better acquainted than with those of more distant localities.

In Torbay the equinoctial spring-tides rise and fall 18 feet in still weather; now the sea can form a beach anywhere at and within the highest and lowest levels it reaches. Moreover, its power to bring shingle is by no means limited to the tidal strand; areas which at low-water are ten or twelve feet below the sea level are certainly within the rolling action of heavy seas. We hear from below—

"The scream of a madden'd beach dragged down by the wave."

Hence we have, in round numbers, a vertical range of 30 feet within which beaches may be formed in the numerous coves and inlets into which the shores of Torbay are broken. A greatly indented coast line is, no doubt, particularly favourable for the formation of contemporary beaches at different levels, and this without taking into account the height above the normal level of even equinoctial spring-tide high-water, which the waves reach during gales of unusual violence. I may mention, in passing, that the great and too fatal gale of October 26th, 1859—sometimes called "the *Royal Charter* storm"—destroyed near Torquay, in the short period of two hours, two sea-walls and the roads they were intended to protect. The base of the parapet of one of the walls was 6 feet above the level of the highest still-weather spring-tide; yet a portion of it, measuring 9 feet in length by 3 feet in breadth and in height, and, therefore, containing 81 cubic feet, and weighing about 5½ tons, was broken off and transported, bodily, 25 feet horizontally, landward; where it was inverted and left.*

In accordance with what has been stated above, modern beaches exist in various parts of Torbay at all levels within the limits named, and without any thing like graduation in their irregularity.

Now, were there to be an uniform upheaval of this district—either paroxysmal or slow and gradual—to the extent of 40 feet, a series of raised beaches would be produced having *no "sort of uniformity in the height attained."* The lowest would be 10, and

* *Geologist*, vol. IV., p. 452.

the most elevated 40, feet above the reach of the highest spring-tide, with others reaching various intermediate levels. The extremes of altitude would not necessarily or probably be at the extremes of distance: but if the elevation were not uniform—were it to reach its maximum at either extremity, or near the centre of the upraised district—the effect might be to augment, and certainly could not be to obliterate or graduate, the inequalities of level; so that we should be prepared, rather than otherwise, for such measurements as Miss Carne mentions at pp. 371–2.

It is scarcely necessary for me to observe again that these brief and hasty remarks are by no means intended to convey any opinion as to whether the "*Cliff Boulders of the Land's-end District*" are or are not to be entitled to the appellation of "*Raised Beaches.*"

Notice of a singular specimen much resembling a Chalk Flint, found in the Balleswidden Mine, St. Just.

By Mr. SAMUEL HIGGS, Jun.,

ASSISTANT SECRETARY TO THE SOCIETY.

The mine in which this curious specimen was found is situated in the parish of St. Just, and is entirely in granite, being distant about two miles from the sea-coast where the clay-slate and hornblende rock intersect, and its produce is wholly tin.

This specimen was found firmly imbedded at the bottom of a vug, or cavity, of the so-called "New Lode" at the 130-fathom level, surrounded with decomposed felspar and quartz. The vug was about 18 inches square, and the lode in this place 7 feet wide. Although the agents have, at my request, carefully examined the the lode in its driving, they have failed to discover any substance at all resembling it.

The New Lode was commenced to be wrought on about four years ago; at the surface it was exceedingly small and poor indeed; it scarcely had the character of a lode, being nothing more than a series of small veins; this continued to the 70-fathom level, where the lode became well defined and productive. From this point to the 140-fathom level it gradually increased in size from 3 feet to 7 and 10 feet wide.

About 12 fathoms east of the vug a large hollow lode, composed entirely of quartz, intersected the New Lode, but it did not in any way disorder it.

For comparison I send some veritable flints found on Solger's Craft, near Carn Kenidjack, which lies about half-a-mile north of this mine. I have found these flints distributed over the whole of the south and south-west slopes of this carn; their presence

there is a singular fact, and it will be observed that there is a great similarity between one or two of them and the subject of this paper, but whether they are identically of the same order I leave to more experienced persons to judge.

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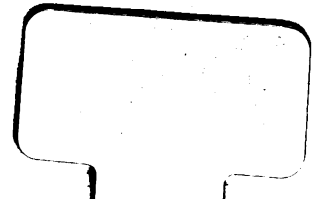

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